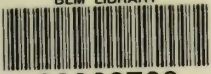


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Handbook of Methods for Locating **Black-Footed Ferrets**

January 1984



Wyoming BLM
Wildlife Technical Bulletin No. 1

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HANDBOOK OF METHODS FOR LOCATING BLACK-FOOTED FERRETS

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1984

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PREFACE

This handbook was prepared to provide guidelines for conducting black-footed ferret [*Mustela nigripes*] surveys. It is designed for use by persons who have had little experience with such surveys but also should provide new information to those more experienced.

The discovery and subsequent studies on black-footed ferrets in South Dakota from 1964 through 1974 and rediscovery of ferrets in northwest Wyoming in 1981 emphasize the need to continue the search for this elusive species.

Our goal is to improve ferret survey techniques. The methods described in this document are state-of-the-art procedures and are expected to improve as new data are collected. Actual field use of methods described in this handbook has been successful in locating ferrets or ferret remains on both black-tailed [*Cynomys ludovicianus*] and white-tailed [*C. leucurus*] prairie dog towns. This success should encourage standardization of survey methods and upgrade the quality and intensity of searches currently being done.

We would like to emphasize that techniques described here are not the only methods potentially available to locate ferrets, but at present are the most effective ones of those we have employed. New techniques need to be developed, and we encourage innovation when possible. We encourage re-evaluation of the current methods as new information becomes available.

This handbook is a cooperative effort with Idaho State University/Biota Research and Consulting, Inc., U.S. Fish and Wildlife Service's Denver Wildlife Research Center and Endangered Species Field Office, Helena, Montana, the Wyoming State Office of the U.S. Bureau of Land Management, and the Wyoming Game and Fish Commission.

ACKNOWLEDGMENTS

Background and ongoing research by Idaho State University/Biota Research and Consulting, Inc. has been funded by a number of organizations including the Wildlife Preservation Trust International, New York Zoological Society's Animal Research and Conservation Center, World Wildlife Fund-U.S., National Geographic Society, Charles A. Lindbergh Fund, National Wildlife Federation, The Nature Conservancy, U.S. National Academy of Sciences, Humane Society of The United States, Defenders of Wildlife, Sigma Xi, Bethesda-Chevy Chase Chapter of Izaak Walton League of America, and the Fremont County (Wyoming) Audubon Society. We sincerely thank these organizations for their contributions to black-footed ferret conservation and recovery. Equally supportive are ranchers in northwestern Wyoming who have allowed us access and who have successfully managed the ferrets on their lands up to present times.

The participation of the Denver Wildlife Research Center and the Endangered Species Field Office, Helena, Montana, were supported by the Endangered Species Program of the U.S. Fish and Wildlife Service.

We wish to thank Jim Roseberry of the Wyoming Bureau of Land Management and Harry Harju of the Wyoming Department of Game and Fish for their support.

INTRODUCTION

The black-footed ferret [*Mustela nigripes*] in the Family Mustelidae and Order Carnivora is the only ferret native to North America (Hall 1981). Current distribution of the ferret is unknown though it is assumed to be greatly reduced from the original range (Linder et al. 1978). Because the ferret is considered one of the rarest and most endangered mammals in North America (Hillman and Clark 1980), it receives full protection under the 1973 Endangered Species Act (P.L. 93-205). As such, special precautions are in order to ensure its survival whenever ferret presence is documented or suspected. In addition, the National Environmental Policy Act (1969) requires assessment of environmental disturbances associated with federal actions which significantly alter the environment. This assessment includes a determination of the potential effects of such action upon any endangered species. For black-footed ferrets, the determination of its presence or absence is based on surveys and inventories done on the site of proposed actions.

This handbook varies from previous ferret survey guidelines by describing and illustrating a wider range of ferret sign, and suggesting optimal seasons to search for ferret evidence. It is divided into 3 parts: (1) general information on ferret life history, (2) ferret signs to be sought during surveys, and (3) procedures to be used in ferret searches. This information is intended to provide wildlife managers with a guideline for conducting ferret surveys and help searchers identify signs made by black-footed ferrets in prairie dog colonies.

PART I: GENERAL LIFE HISTORY

Ferret Literature

Most ferret literature not cited in this handbook is appended. Hillman (1968), Henderson et al. (1969), and Hillman and Linder (1973) are three key papers which describe the South Dakota studies. Hillman (1968) describes field observations of ferrets over 16 months, Henderson et al. (1969) give the single most comprehensive account of the ferret and numerous details of its life history, and Hillman and Linder (1973) provide additional information summarizing many of their field experiences.

Characteristics and Identification

The back (except for a dark saddle) and sides of black-footed ferrets are a pale yellowish-buff or buckskin color with lighter areas on the face, chest, and abdomen (Figs. 1-2). Contrasting black markings occur as a mask across the eyes, on the feet and legs, and on the tip of the tail. The pelage has a sleek appearance because of short guard hairs and does not change color in winter.

Black-footed ferrets have long thin bodies. Adult males range in total length from 500 to 533mm with a tail length of 114 to 127mm. Linear measurements of females average about 10% smaller (Hall 1981). Adult weights range from 650 to 1400g.

Two other species of *Mustela*, long-tailed weasels [*M. frenata*] and domestic (sometimes feral) European ferrets [*M. putorius*] may be confused with black-footed ferrets. Long-tailed weasels are much smaller (325mm, 250g), light to dark brown above and yellow below (in summer) or white (in winter), and have a long black-tipped tail. European ferrets are approximately the same size as black-footed ferrets, vary from yellowish to dark brown in color, have distinct black legs and feet, and a faint mask around the eyes. The tail tapers to a point and is black its entire length. The pelage differs greatly from the black-footed ferret's in its extreme coarseness with long dark-tipped guard hairs.

It is quite common to find long-tailed weasels in ferret habitat. It is unlikely to find European ferrets on prairie dog colonies, but some have been observed where prairie dogs reside near human populations.



Figure 1. The black-footed ferret. (photo by Tim Clark)



Figure 2. The black-footed ferret. (photo by Tim Clark)

Habitat

The close association of black-footed ferrets and prairie dogs is well documented (Hillman and Clark 1980). Black-footed ferrets rely on prairie dogs for both food and shelter (Hillman 1968, Henderson et al. 1969, Linder et al. 1972). Because of this, all active prairie dog colonies are potential black-footed ferret habitat.

Historically, the range of the ferret coincided closely with the range of prairie dogs throughout the Great Plains, semi-arid grasslands, and mountain basins of North America (Hillman and Clark 1980). Presently, the only known ferret population is in northwestern Wyoming. Hillman (1974) and Choate et al. (1982) stated that ferrets may have been more numerous than previously reported. We agree and believe that there may still be remnant ferret populations in parts of their historical range.

Breeding

Ferrets have not been observed mating in the wild, but captive black-footed ferrets have been observed breeding in March and early April (Hillman and Carpenter 1980). Support for believing wild ferrets breed during this period comes from an adult male ferret road-killed in early March in northwestern Wyoming which showed spermatogenesis (Thorne 1982, Wyoming Game and Fish Dept., pers. comm.). Further evidence comes from winter snow tracking information which showed significant increases in movements by individuals during this period (Clark et al. 1983a, in manuscript).

Time of parturition is also unknown but is suspected to occur in May and early June (Henderson et al. 1969, Fortenbery 1972). Captive ferrets have a known gestation period of 42-45 days (Hillman and Carpenter 1980) and litter size ranged between 3-4 compared to 3-5 reported in South Dakota (Hillman 1968, Henderson et al. 1969, Fortenbery 1972). First observations of eleven Wyoming ferret litters were made between July 7 and July 29 after the ferrets resided approximately 45 days below ground. At first appearance, juvenile ferrets appeared approximately two-thirds to three-quarters grown. Young ferrets observed in South Dakota were similar in size at the time of emergence (Hillman 1968, Henderson et al. 1969).

In Wyoming ferret family units remain together until late August. At this time, juveniles still rely on their dam for food to some extent but are frequently separated from siblings in different burrows. The young spend more and more time on their own and are independent by mid-September.

Activity Patterns

Ferrets may be active at all hours of the night and, in summer and fall, at irregular times during daylight hours.

PART II: FERRET SIGN SOUGHT DURING FERRET SEARCHES

As discussed by Hillman and Linder (1973), locating ferrets is very difficult—"characteristic ferret sign is nebulous" and "positive identification of ferret activity is difficult during all seasons." Ferret search techniques, originally outlined by Henderson et al. (1969) for black-tailed prairie dog colonies, are generally effective on both black-tails and white-tails but have needed more refinement.

During black-footed ferret searches, we distinguish between observations of ferrets and observations of ferret sign.

Observation of Ferrets

During spotlight searches for ferrets, first observation usually occurs when a ferret's green eyeshine is reflected in the spotlight. Over about 20m, the observer will see both eyes shining a very bright green. The maximum distance eyeshine can be observed depends on vegetative cover and terrain but may exceed 150m. At close distances, the animal itself will be visible. Unfortunately, green eyeshine is also typical of most other mustelids and several other animals (Table 1) such as long-tailed weasels, badgers [*Taxidea taxus*], and antelope [*Antilocapra americana*]. Positive identification

frequently requires close approach (vehicular or on foot) or careful observation using a spotting scope or binoculars. With experience, a searcher learns to discern differences in eye size, interorbital distances, and animal behavior, thus improving identification.

Ferret Sign

Black-footed ferret sign includes dirt diggings, tracks, scats, and skeletal remains.

(1) Dirt diggings

Ferrets excavate soil from within prairie dog burrows and deposit it in unique configurations. These diggings are probably related to prey acquisition. Diggings have traditionally been referred to as "trench-like" or "trenches" (Hillman 1968, Henderson et al. 1969, Fortenbery 1972, Hillman and Linder 1973). Observations in Wyoming (Clark et al. 1983c, in ms.) indicate that this is misleading because only 7% of the observed diggings were trench-like in appearance. Diggings are mounds of excavated subsoil rather than depressions in surface soil. Soil is drawn from prairie dog burrows and heaped into distinctive piles on the surface. Troughs are formed when ferrets move backward dragging soil with the front legs.

Table 1
Animals Commonly Observed While Spotlighting
and Their Respective Eyeshine Color

Animals	Species	Eyeshine Color
Antelope	<i>Antilocapra americana</i>	Green
Badger	<i>Taxidea taxus</i>	Green
Bobcats	<i>Lynx rufus</i>	Yellow
Burrowing owls	<i>Speotyto cunicularia</i>	Yellow
Cattle	<i>Bos spp.</i>	Green
Common night hawk	<i>Chordeiles minor</i>	Pink
Coyotes	<i>Canis latrans</i>	Green/yellow
Horses	<i>Equus spp.</i>	Green/yellow
Jackrabbit	<i>Lepus spp.</i>	Red
Mule and white-tailed deer	<i>Odocoileus hemionus</i> , <i>O. virginianus</i>	Green
Raccoons	<i>Procyon lotor</i>	Yellow
Skunks	<i>Mephitis mephitis</i>	Yellow/green
Swift and red foxes	<i>Vulpes fulva</i> , <i>V. velox</i>	Yellow, yellow/green

From a sample of 100 ferret diggings, 5 general digging configurations were identified (Figures 3a-e). Some additional diggings are shown in Figures 4a-g. All digging configurations commonly had old, dried prairie dog feces scattered along their outer edges. Stones up to 5cm in diameter were found in some diggings. (Larger stones are commonly found in badger diggings.) Table 2 lists the characteristics of these digging types.

Fortenbery (1972) and Henderson et al. (1969) initially reported the more frequent presence of diggings in winter due to reduced prairie dog activity. Clark et al. (1983c, in ms.) also noted a marked seasonality in the density of ferret diggings and in the percentage of prairie dog burrow entrances with diggings. Peak values for both occurred in January (density of 2.5 diggings/ha and 4% of all burrow entrances) with a drop to near zero in April. The number of diggings/ha remained very low from April through September, when the numbers again increase. The best time to find diggings was between December and March.

Diggings generally did not remain recognizable as those made by ferrets for more than 2 months (Clark et al. 1983c, in ms.). After prairie dogs emerged from hibernation in early February, 70% of ferret diggings under observation were destroyed by the prairie dogs, by incorporating the loose material back into their mounds as part of normal mound maintenance activity. The remainder of the sample was destroyed by wind and rain within 1-2 months. Erosion tended to flatten and widen the diggings, making them unrecognizable as ferret diggings within a few days, especially to inexperienced observers. Since ferret diggings occur at such low frequencies during the summer and are so short-lived, we discourage intensive summer surveys for ferret diggings but recommend searchers be alert to the possibility of finding diggings during the summer months.

(2) Tracks

Ferret tracks are readily identifiable in the winter when snow is present. Depending on weather conditions (wind, temperature, etc.), ferret tracks may be recognizable even when several days old. Generally, one should search for tracks immediately after a fresh snowfall to obtain a sure identification.

Measurements of individual tracks in snow averaged 3.1cm wide (SD=0.63) and 5.5cm long (SD=0.84) in Wyoming (Fig. 5; Clark et al. 1983d, in prep.). Ferrets make the characteristic mustelid "twin-print" track pattern. Each "twin-print" pattern typically measured 5-6cm wide and 8-9cm long. Stride lengths between the twin prints (interstride length) averaged 48cm (range=6-99cm). Hillman (1968) reported that interstride lengths of walking South Dakota ferrets ranged from 15-20cm while those running ranged from 35.6-43.2cm. Tracks of mink [*Mustela vison*] are indistinguishable from those of ferrets (3.5cm wide; 4.4cm long; 30.5-58cm interstride distance). Observers should suspect mink presence near streams, ponds, or stock tanks. In these areas, tracks can only be confirmed as ferret when diggings are found associated with tracks.

(3) Scats

Ferret scats, although rarely found, should not be overlooked as ferret sign. They are typically long and thin, either linear or folded back on themselves, and generally tapered at both ends (Fig. 5). Scats are generally black with gray or brown casts and contain animal hair (e.g. yellowish prairie dog fur), occasional bone fragments, and rarely plant material. Seventeen ferret scats were found in Wyoming. Unfolded scats averaged 5.8cm long (range=3.0-9.9) and folded scats averaged 4.2cm long (range=3.0-5.8). Average maximum diameter was 0.9cm (range=0.5-1.3) (Figure 6).

Sheets et al. (1972) described ferret scats found in South Dakota as dark brown to black with hair exposed on the surface and often covered by white or yellow mold. They measured 82 scats retrieved from prairie dog burrows giving dimensions of 1.0-7.6cm in length and about 0.6cm in diameter.

Table 2
Characteristics of Five Types of Ferret Diggings

Description of Excavated Subsoil ¹	Sample size (%)	Dimensions in cm				Trough size in cm				Diggings by Month					
		Length \bar{x} \pm SD ²	Width \bar{x} \pm SD	Depth \bar{x} \pm SD	Range	Length \bar{x} \pm SD	Width \bar{x} \pm SD	Depth \bar{x} \pm SD	Range	Dec	Jan	Feb	Ma		
FERRETS															
Single lobe, full trough	7 (7%)	138 56 76-241	22 9 11-36	8 5 3-18		138 56 76-241	13 3 10-15	4 2 3-8		0	6	1	0		
Single lobe, short trough	56 (56%)	116 39 51-198	40 12 18-74	12 6 4-25		63 32 20-173	14 10 8-25	3 1 1-5		0	24	14	18		
Single lobe, no trough	26 (26%)	121 59 31-353	51 24 20-130	9 3 4-15		—	—	—		1	4	7	14		
Multi-lobed, with trough	8 (8%)	93 17 71-122	45 24 23-91	13 4 5-15		71 21 46-102	11 1 10-13	4 2 3-5		0	3	5	0		
Multi-lobed, no trough	3 (3%)	139 13 127-152	57 22 38-81	11 2 10-13		—	—	—		0	0	0	3		
Totals	100 (100%)	117 46 31-353	42 19 11-130	11 5 3-25		73 41 20-241	12 4 8-25	3 1 1-8		1	37	27	35		
BADGERS															
	14 (100%)	102 39	42 14	13 5		—	—	—		0	12	2	0		

¹See Figure 3 and text for full descriptions.

²Standard deviations of measurements.

Figure 3a-e. Types of black-footed ferret diggings on white-tailed prairie dog colonies in northwestern Wyoming.



Figure 3a. Single lobe with trough full length ("Classic" type, Henderson et al. 1969:16)—7% of sample.

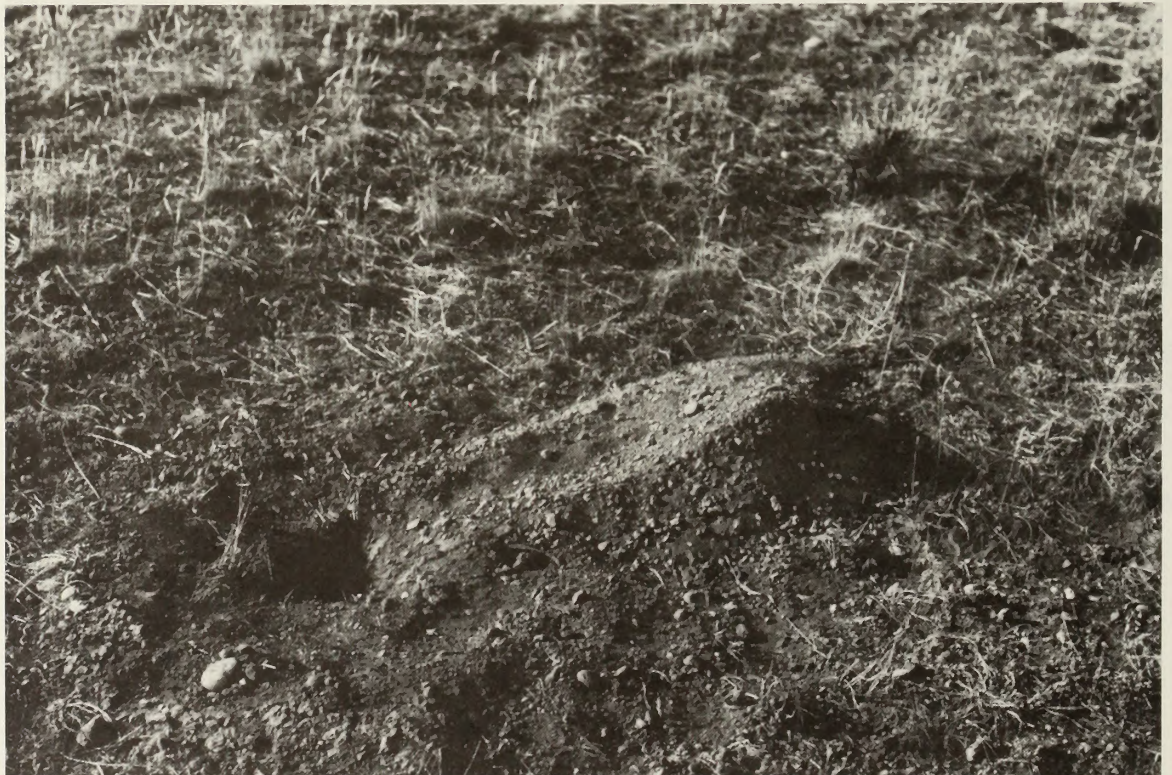


Figure 3b. Single lobe with short trough—56% of sample.



Figure 3c. Single lobe with no trough—26% of sample.



Figure 3d. Multi-lobe with trough—8% of sample.



Figure 3e. Multi-lobe with no trough—3% of sample.

Figures 4a-g. Additional black-footed ferret diggings (approximate scale can be determined by noting burrow openings as 10cm in diameter). (photos by T. Campbell, T. Clark)



Figure 4a.



Figure 4b.



Figure 4c.



Figure 4d.



Figure 4e.



Figure 4f.



Figure 4g.

Figures 5a-g. Black-footed ferret tracks in snow about 8cm deep. (photos by L. Richardson, T. Clark, T. Campbell)



Figure 5a.

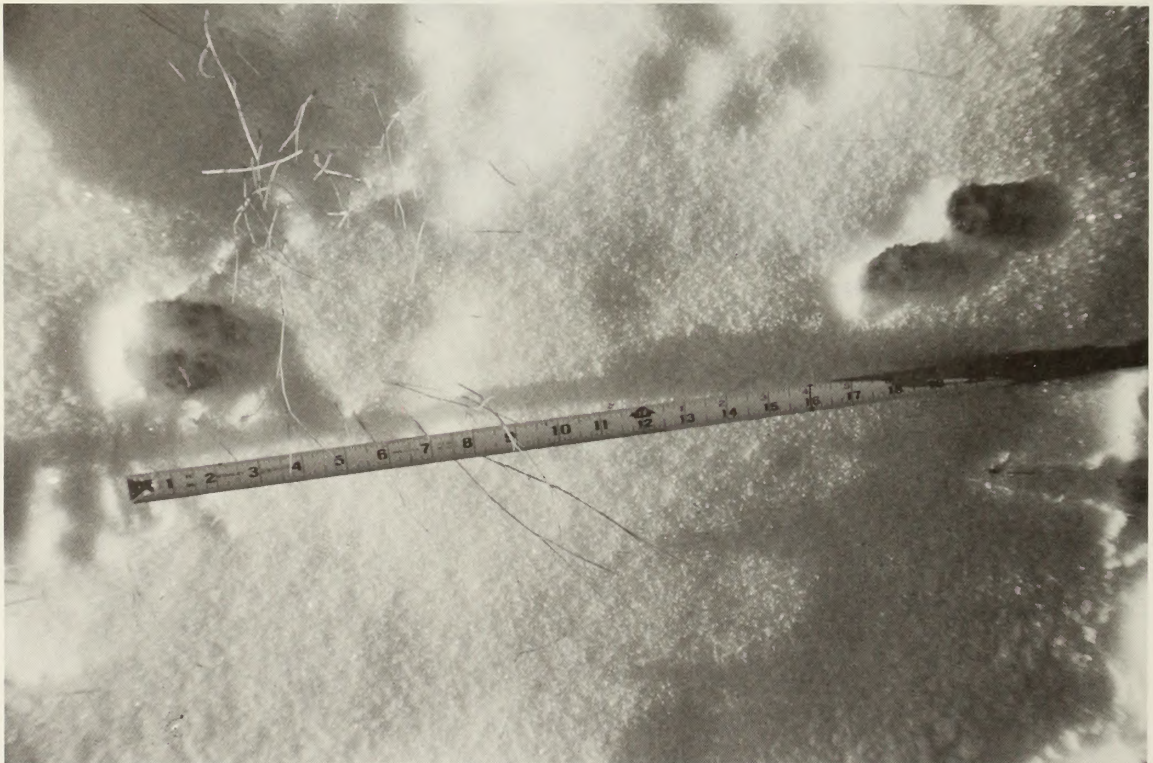


Figure 5b.



Figure 5c.

Figure 5d. Black-footed albatross tracks in snow along a dirt road, Laysan Island, Hawaii, August 1963. Photo by J. C. Thompson.



Figure 5d.



Figure 5e.



Figure 5f.



Figure 5g.

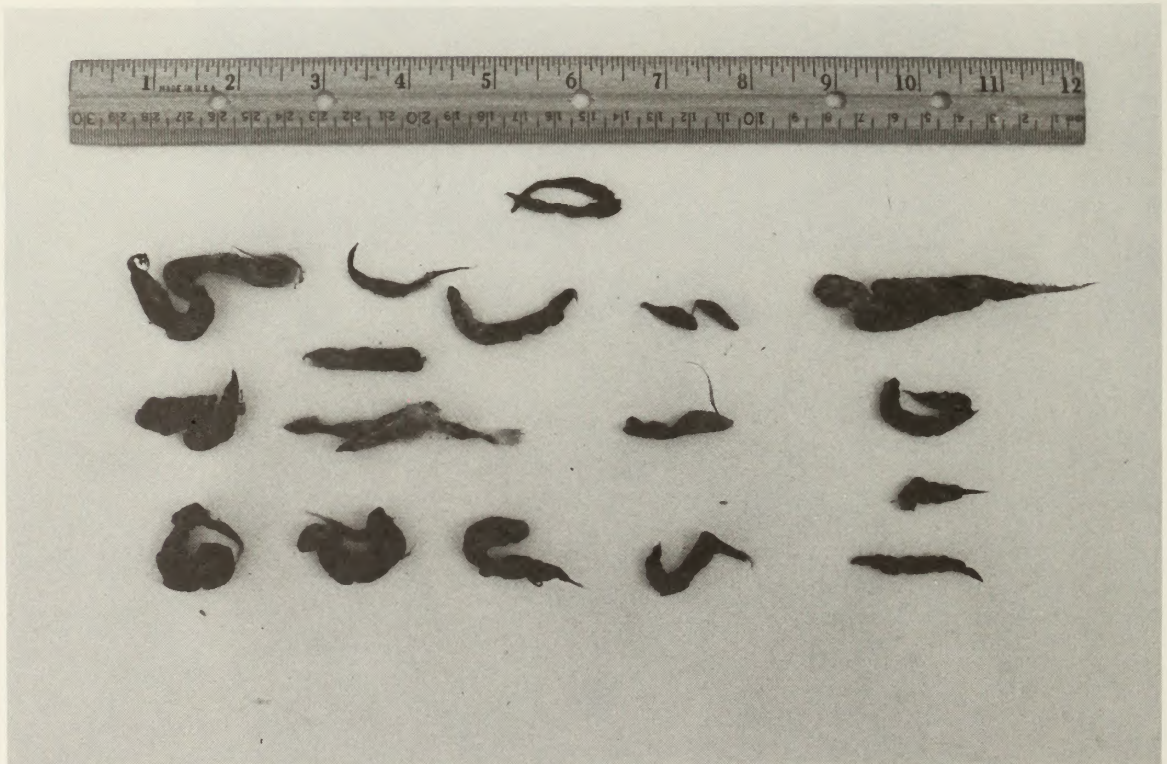


Figure 6. Known black-footed ferret scats. (photo by T. Clark)

(4) Ferret skulls

Black-footed ferret skulls are rarely found but provide evidence of past ferret presence. The discovery of a skull should dictate a very intensive follow-up survey. Clark et al. (1983a, in ms.) found only 10 skulls after intensive on-foot coverage of 2,868 ha of ferret-occupied region (Fig. 7). Intensive surveys for ferrets by the US Fish and Wildlife Service resulted in 7 skulls on 400 colonies surveyed (Martin and Schroeder 1979). Ferret skulls are quite similar to mink skulls (Fig. 8). A key to ferret, mink, and weasel skulls is provided in Appendix IV.

(5) Other sign

Henderson et al. (1969) reported that black-tailed prairie dogs plug prairie dog burrows occupied by black-footed ferrets. They do this by filling the hole from above with loose dirt and small stones. This plugging activity has been considered an indicator of ferret presence. Clark et al. (1983c, in ms) studied hole-plugging on ferret-occupied white-tailed prairie dog towns in Wyoming and found the rate of plugging in response to ferret presence to be very low and erratic. Surveys conducted by the U.S. Fish & Wildlife Service in western Wyoming from 1978 to 1982 on 181 white-tailed prairie dog towns varying from 2.0 to 197 ha showed that less than 1% of 243,915 holes checked were plugged. Hillman (1968) reported that the existence of plugged burrows on black-tailed prairie dog towns where no other ferret sign is present does not provide a reliable indicator of ferret presence. In South Dakota he learned that on small prairie dog towns of less than 40 acres, 15 to 25% of the burrows may be plugged. On

large towns the percentage of plugged burrows is smaller. Plugged burrows can be found on nearly all prairie dog towns, but a large number of them concentrated in portions of the town may be indicative of ferret activity (Hillman and Linder 1973). Though hole-plugging may be of limited value in determining ferret presence, it should be considered reason to intensify spotlight surveys if numerous holes are found plugged in a small section of a larger prairie dog town and other reasons for plugging behavior does not exist. Observers may have difficulty distinguishing between burrows plugged by prairie dogs, burrows plugged from underground by pocket gophers, and burrows which have collapsed or been filled in by wind-blown material.

Another sign of possible ferret presence is a dual puncture hole pattern at the back of prairie dog skulls indicating mustelid predation. Biota Research and Consulting, Inc. examined a sample of about 2,000 prairie dog skulls from the ferret-occupied area in Wyoming with only one skull exhibiting these marks. Although we do not consider these to be high priority among ferret signs, those searching for ferrets should be aware of them in case they are encountered. A comparison of post-cranial skeletons of the prairie dog [*Cynomys spp.*] and the black-footed ferret [*Mustela nigripes*] is provided in Appendix V.

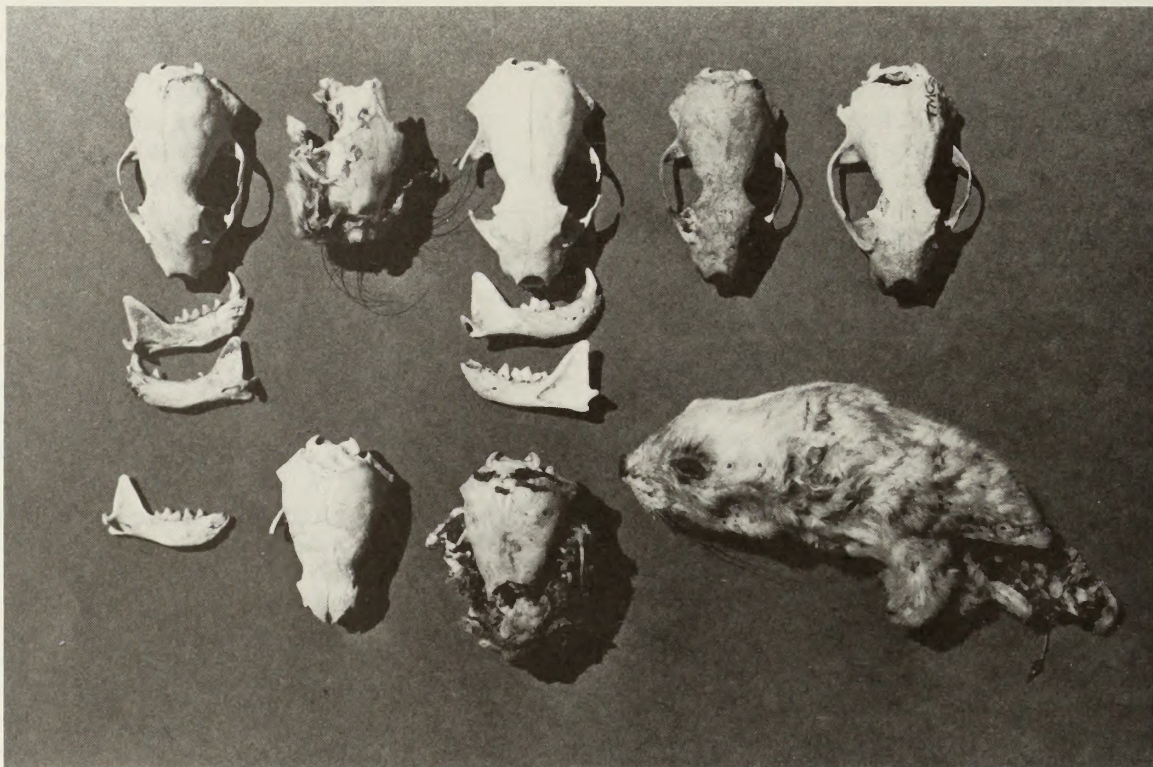


Figure 7. Some black-footed ferret skeletal remains found in northwestern Wyoming. (photo by T. Clark)



Figure 8. Ventral view of mink skull (left) and black-footed ferret skull (right). Note shape of auditory bullae and length of rostrum. (photo by T. Clark)

PART III: FERRET SEARCH PROCEDURES

Timing

Ferret presence is most easily detected during two periods of the year: late summer and winter. These two periods require the use of very different methods of ferret searches:

(1) **Late summer (July 1-September 15) nocturnal surveys for ferrets**—During this period, ferret litters were seen above ground in South Dakota (Henderson et al. 1969; Fortenberry 1972) and Wyoming. During this 77-day period, we recommend intensive spotlighting searches following search procedures given below.

(2) **Winter (December 1-April 15) diurnal surveys for ferret sign**—This period is the best for observing ferret sign. Ferret diggings in particular are most abundant because prairie dogs are either hibernating (white-tails) or relatively inactive (black-tails) and do not destroy ferret diggings.

Procedures for Finding Ferrets

We recommend that all ferret searchers be field-experienced biologists who have had a formal introduction to black-footed ferrets via an intensive field workshop. This course should provide prospective searchers with experience with white-tailed and black-tailed prairie dogs, black-footed ferrets and their sign, related species, and other animal signs likely to be encountered. All ferret search teams should consist of at least two persons.

Pre-Survey Procedures

(1) Before beginning a black-footed ferret survey, searchers should read the pertinent literature on ferrets. References for the bulk of this literature are presented in this document and its appendices.

(2) Searchers should familiarize themselves with differences between black-footed ferrets, European ferrets or polecats, long-tailed weasels, mink and badgers. Searchers should visit museums to examine skins and skulls of each species and become familiar with the sign of each species.

(3) Searchers should solicit background information on ferret and prairie dog presence in the general and specific study areas to be searched from other researchers, local residents, and federal and state agency personnel.

Potential Habitat Survey

(4) Locate all prairie dog colonies within your study area during snow-free months. We have found that helicopters are best suited for this task when surveying large areas. We do not recommend fixed-wing aircraft because of a high minimum speed and relatively poor visibility. Small areas can frequently be surveyed from the ground by driving available roads and scanning from high points.

(5) All colonies located should be accurately mapped on 7.5 or 15 minute U.S. Geological Survey topographic maps. Mapping is most accurately done once the distribution of the prairie dog burrow openings in each colony has been determined by walking and driving.

Diurnal Ferret Sign Surveys

(6) Diurnal surveys for ferret sign should be conducted between December 1 and April 15 when snow may be on the ground and prairie dogs are relatively inactive.

(7) Winter surveys should be conducted on foot, snowmachines, or possibly on motorcycles. The surveys should be made on 3 different occasions of at least 14-day intervals for each colony searched. Small colonies (80 ha) should be surveyed on foot. Large colonies can be surveyed in a more effort-effective manner by using one of the vehicles mentioned above depending on conditions.

(8) When possible, winter diurnal surveys should be timed to begin within 1 hour after sunrise after a fresh snowfall during the previous night. Ferret tracks can be located in the fresh snow. Ferret diggings may be clearly visible both on top of fresh snow or on relatively snow-free areas.

(9) To search for tracks and diggings, searchers should begin at the edge of a colony and each should move back and forth within a 50-m wide transect to the far edge of the colony. Searchers should examine all prairie dog burrow openings, mounds, and adjacent areas, as well as the overall surface of the colony. In snow-free areas, each burrow should be marked with a footprint to assure complete and non-overlapping coverage. This pattern of search should be repeated until the entire colony has been surveyed.

(10) Searchers should search for partially destroyed or deteriorated ferret diggings as well as intact ones. Any diggings suggesting ferret presence should be photographed, measured, and sketched similar to Figure 9.

(11) If sign suggestive of ferret presence is found, spotlighting should be conducted following methods described below.

Nocturnal Ferret Surveys

(12) Nocturnal field searches should be conducted between July 1 and September 15 and as follow-up to winter diurnal surveys if sign is found. During late summer, juvenile ferrets are above-ground and females spend much time above-ground hunting.

(13) Before dark, a spotlight route should be located (and flagged, if necessary) on the colony to provide as much coverage as possible. The spotlight route should conform to the topography and vegetation of the colony taking advantage of high vantage points where possible to view clearly the maximum surface area. Each colony will require a unique, site-specific travel route. This route should be drawn on the map prepared earlier.

(14) Spotlighting should be done from a vehicle using bright headlights and a roof-mounted moveable spotlight (100-watt aircraft landing bulb) operated by the driver. If present, a second searcher seated in the rear of the truck should use a handheld spotlight of similar specifications. The driver spotlights areas to the front and sides of the vehicle while the second searcher spotlights to the sides and rear.

(15) The spotlights should be moved to cover all areas, focusing on individual prairie dog mounds, and then retracing the path of the light. It is important to retrace the original light path because sometimes ferrets will not face the beam on the first pass but will do so on subsequent passes of the light.

(16) Spotlighting should commence at dusk and continue until dawn, to cover all periods of possible activity each night. We have found ferrets most active just after dusk and particularly during the two hours prior to dawn, but they have been observed at all hours (Clark et al. 1983b, in ms.).

(17) This procedure should be repeated on each prairie dog colony for five consecutive nights. We recommend a standard search of three to five nights depending on colony size; three nights on colonies less than 120 ha, five nights on colonies 120 ha or larger. If sign suggesting ferret presence is found or if unidentified green eyeshine is observed, a seven-night search should be conducted.

(18) Evidence of nocturnally active animals, in particular ferrets, will be obtained from eyeshine. Upon locating green eyeshine, first try to identify the animal with binoculars or spotting scope. Next, rapidly move to within 50-m to make a positive identification, if possible. A quiet, on-foot approach in the spotlight beam can sometimes aid in identification. If the animal descends a prairie dog burrow, wait for it to reappear. Ferrets, badgers, and weasels tend to be very curious and often will emerge from a burrow within a few minutes. Sometimes turning the engine of the vehicle off or moving further away from the burrow will result in the unknown animal surfacing.

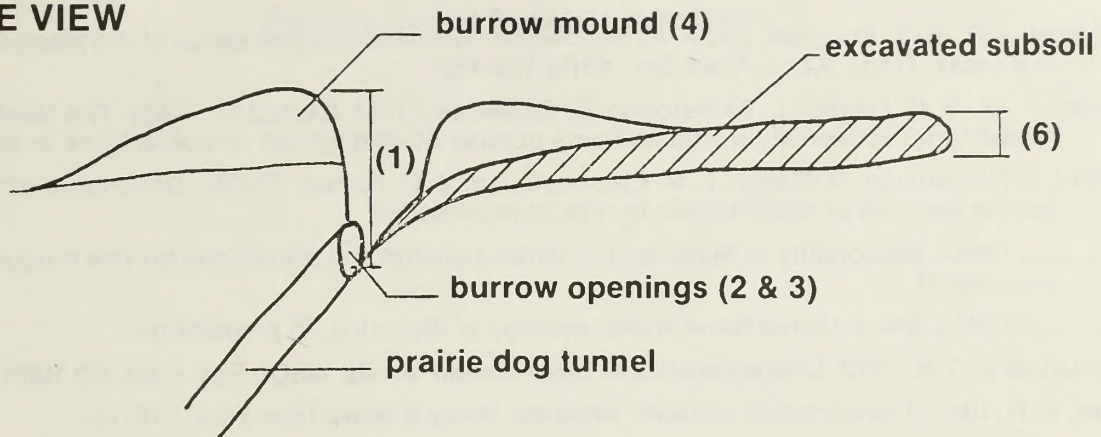
(19) Each morning just after sunrise, search each colony by walking or driving through each hectare to locate freshly excavated soil. Any sign suggesting ferrets should be photographed immediately and marked so it can be relocated for focus of the next night's spotlighting.

(20) If a ferret is found, take as many photographs as possible while the animal is above ground. A camera with flash attachment should be ready.

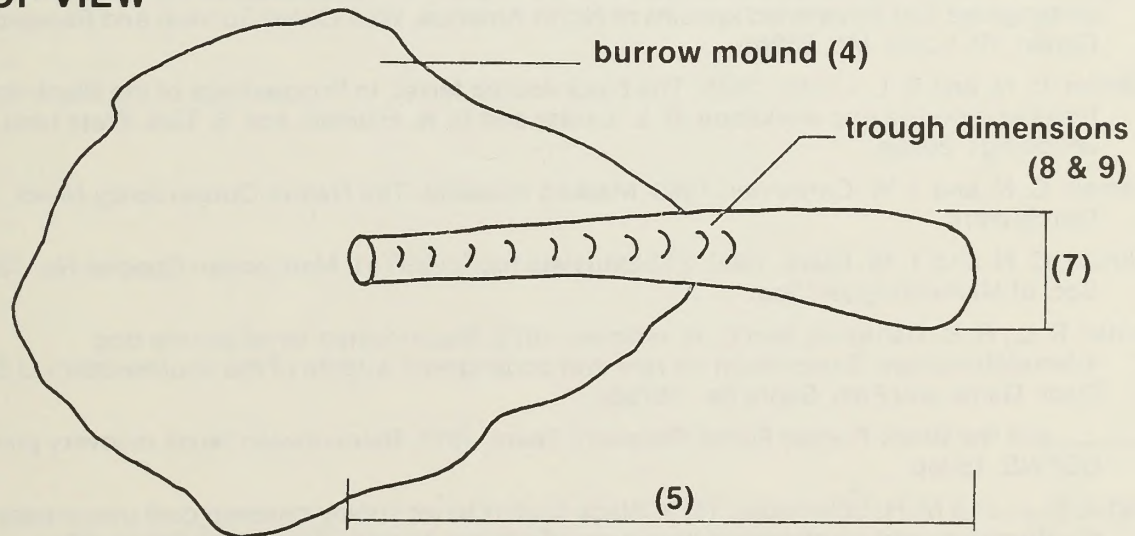
(21) Notify the appropriate state and federal agencies as soon as possible the next morning.

(22) We suggest searchers attempt to quantify nocturnal search effort on each prairie dog colony. Determine the area of the colony and measure the length of the spotlight route and the width of the spotlight beam on both sides of the travel route. From these, calculate the area covered by the spotlighted belt transect and determine the percentage of the colony spotlighted. An estimate the percentage of each colony covered by shrubs and their mean height should also be made.

SIDE VIEW



TOP VIEW



- (1) hole depth
- (2) hole height
- (3) hole width
- (4) mound vs no mound
- (5) subsoil length
- (6) subsoil height
- (7) subsoil width
- (8) trough length
- (9) trough depth
- (10) other (stones, feces)

Figure 9. Measured characteristics of subsoil piles excavated by ferrets and of associated prairie dog burrow entrances and mounds.

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Primary Ferret Survey Literature

Mustela nigripes. By Conrad N. Hillman and Tim W. Clark

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Mustela nigripes Audubon and Bachman, 1851

Black-footed Ferret

Putorius nigripes Audubon and Bachman, 1851:297. Type locality Fort Laramie, Goshen Co., Wyoming.

Mustela nigripes Miller, 1912:102.

CONTEXT AND CONTENT. Order Carnivora, Family Mustelidae, Genus *Mustela*, Subgenus *Putorius*. There are about 14 living species of *Mustela* including three of *Putorius*. No subspecies of *M. nigripes* have been recognized.

DIAGNOSIS. *Mustela nigripes* is about mink-sized; upper parts are yellowish buff, occasionally whitish, especially on the face and venter (Fig. 1); feet are black; tail is tipped with black; mastoid process is notably angular (Fig. 2) (Long, 1965). Ferrets (subgenus *Putorius*) differ from other *Mustela* (weasels and mink) in being larger than weasels and in having the following combination of characters: ventral and dorsal pelage without sharp boundary (it is present in some species of weasels); light and dark markings present on face (lacking in most weasels and mink); legs darker than body; body yellowish brown or whitish and somewhat obscured by darker guard hairs; and more angular mastoid process. The black-footed ferret differs from the Old World ferrets (*M. putorius*) in having greater contrast between blackish feet and paler body, and usually shorter black part of tail (distal third or less). Pelage differences between *M. eversmanni* and *M. nigripes* are very slight. Anderson (1977) examined 19 skulls of *M. eversmanni* and 79 skulls of *M. nigripes*; there were no significant differences in size between the two species.

GENERAL CHARACTERISTICS. Range of external measurements (in mm) of adult males: total length, 500-533; length of tail, 114-127; length of hind foot, 60-73; ear from notch, 29-31. Basilar lengths of skull of two males from Coolidge, Kansas, are 62.2 and 66.8 mm, and zygomatic breadths are 38.8 and 43.0 mm. Tail vertebrae are 17 in number, and their combined length is 22 to 25% of length of head and body. Females average approximately 10% smaller than males in linear measurements (Hall and Kelson, 1959).

DISTRIBUTION. Formerly, black-footed ferrets were found throughout the Great Plains, mountain basins, and semi-arid grasslands of North America (Fig. 3). The geographic range of the black-footed ferret nearly coincides with the range of the prairie dogs (*Cynomys* spp.) (Hall and Kelson, 1959).

Although the past history of the ferret is poorly understood, Hillman (1974) noted that ferrets may have been more abundant than previously reported. Recent evidence reported by Clark (1978) showed that ferrets occurred further west in Wyoming than previously known. The present range is unknown, but it is certainly much smaller than the historic range. Several records (mostly unverified) from Montana, North Dakota, South Dakota, Nebraska, Oklahoma, Kansas, Wyoming, Colorado, and New Mexico were reported in Linder and Hillman (1973). It appears that several remnant ferret populations may remain in parts of its former range.

FOSSIL RECORD. The earliest record of *M. nigripes* is from an upper Illinoian deposit in Clay County, Nebraska. It is also known from Sangamon deposits in Nebraska, and Medicine Hat, Alberta. Wisconsin records include Old Crow River, Yukon Territory; Orr Cave, Montana; Jaguar Cave, Idaho; Little Box Elder Cave, Wyoming; Chimney Rock, Colorado; Isleta Cave, New Mexico; and Moore Pit, Texas (Anderson, 1973, 1977). Anderson (1977) reported the presence of ferrets in central Alaska. Comparison of the Alaskan material with both Pleistocene and Recent *M. (Putorius) nigripes*, Recent *M. (P.) eversmanni*, and Recent *M. (P.) putorius* showed that the specimens most closely resemble *M. (P.) eversmanni michnoi*. The question of conspecificity between *M. nigripes* and *M. eversmanni* is yet to be resolved.

Ferrets are thought to have entered the New World from Siberia, spread across Beringia, and then advanced southeastward to the Great Plains through ice-free corridors. Prairie dog (*Cynomys*) remains were found at six of the Pleistocene sites yielding ferrets. Apparently, ferrets and prairie dogs have remained in close association to the present (Clark, 1975).

ONTOGENY AND REPRODUCTION. Aspects of the reproductive biology of captive ferrets were described by Hillman and Carpenter (unpublished manuscript). Captive females en-

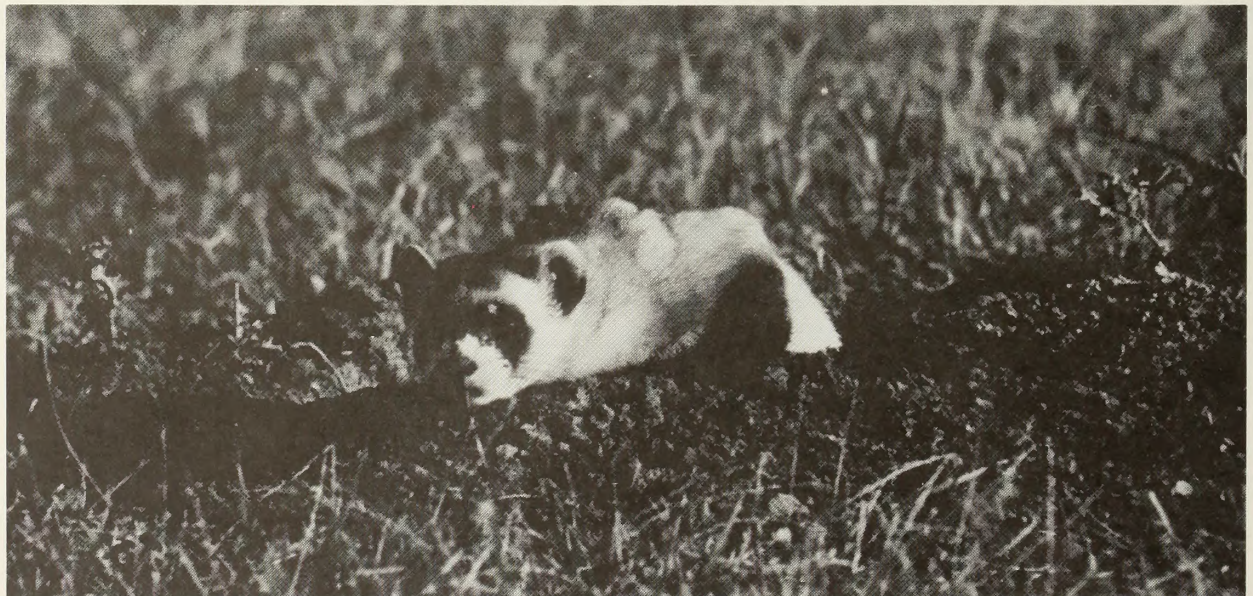


FIGURE 1. A black-footed ferret in a prairie dog burrow. Note distinct black mask and feet.

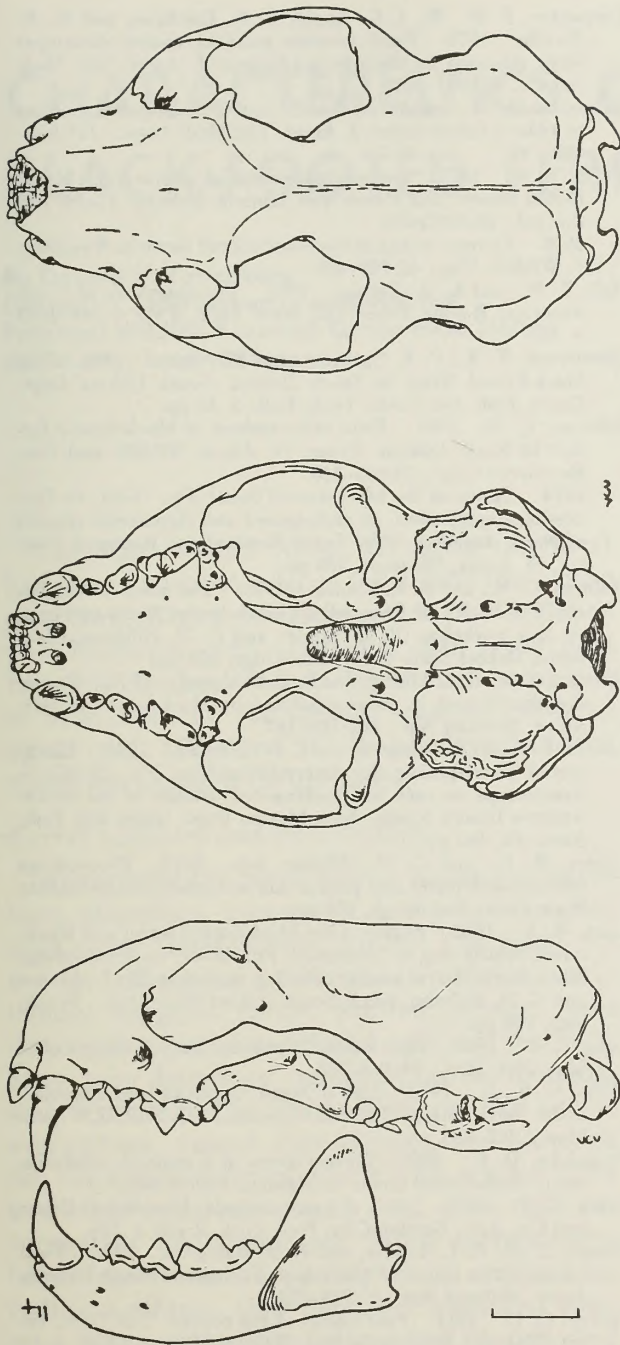


FIGURE 2. Views of skull of *Mustela nigripes* (from Hall and Kelson, 1959:915, by permission of Ronald Press, Inc., New York). The scale represents 10 mm.

tered breeding condition in late February to early March. Length of proestrus lasted 21–28 days; estrus was characterized by vulvar swelling and a sparse mucus-like discharge. Copulation occurred in March and early April, and gestation of one female in two breeding seasons was 42 and 45 days. Litter size of wild females ($N = 11$) averaged 3.5 (range 1 to 5) (Linder et al., 1972). Two litters of five each were produced in captivity; description and measurements of young were described by Hillman and Carpenter (unpublished manuscript). However, information on growth and development is lacking as young did not survive. Young ferrets are rarely observed in the wild before appearances above ground in July, at which time most young approach adult size (Hillman and Linder, 1973).

ECOLOGY. Historical and recent literature document the close association of black-footed ferrets and prairie dogs (Seton, 1929; Cahalane, 1954; Hall and Kelson, 1959; Henderson et al.,

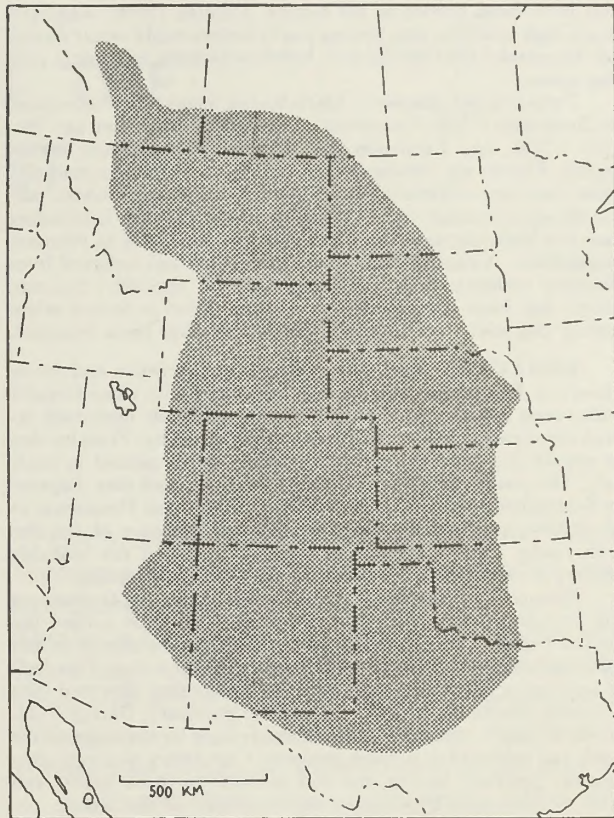


FIGURE 3. Distribution of *Mustela nigripes* in central North America (modified from Hall and Kelson, 1959:915).

1969; Linder et al., 1972; Hillman and Linder, 1973; and Hillman, 1974). Ferrets prey on prairie dogs and utilize their burrows for shelter and denning. Sheets et al. (1972) found prairie dog remains in 91% of the ferret scats analyzed ($N = 82$); mice (unidentified) occurred in 26% of the scats. Alternate prey may be important if prairie dogs are not available (Lock, 1973; Clark, 1978). Hillman (1968) reported that ferrets consumed both live and dead thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*), cottontail rabbits (*Sylvilagus floridanus*), deer mice (*Peromyscus* spp.), and birds that were offered in feeding trials.

Predation by ferrets does not significantly reduce prairie dog populations because ferrets tend to kill only what they can eat. Prairie dog numbers declined in portions of towns frequented by ferrets; however, total numbers were not greatly reduced. The comparatively high breeding potential of prairie dogs offsets the effect of ferret predation (Hillman, 1968; Hillman and Linder, 1973).

The distribution and characteristics of prairie dog towns in one area of South Dakota inhabited by ferrets were described by Hillman et al. (1979). Mean distance between prairie dog towns was 2.4 km; mean distance between towns inhabited by ferrets was 5.4 km (range 1.0 to 11.1). Ferrets have a tendency to reoccupy prairie dog towns that they inhabited in prior years. Information on ferret movements and size of home range is lacking, however. The fall dispersal of young ferrets and occasional road-kills suggest that some movements may be extensive (Hillman and Linder, 1973).

Factors that have caused the decimation of ferret populations have been discussed by Seton (1929), Cahalane (1954), Henderson et al. (1969), and many others. The ferret's decline was related to habitat destruction caused by prairie dog control and agricultural land-use changes. Direct effects of man included trapping, shooting, use of toxicants that exhibit secondary poisoning (example, Compound 1080), and highway mortalities.

Many avian and mammalian predators are attracted to prairie dog towns where they may encounter ferrets. Sperry (1941) found ferret remains in three coyote (*Canis latrans*) stomachs. A ferret was found in a golden eagle (*Aquila chrysaetos*) nest, and great horned owls (*Bubo virginianus*) have been observed attempting to take ferrets (Henderson et al., 1969). Domestic dogs and cats

also have been known to kill ferrets. Hillman (1974) suggested that a high mortality rate among young ferrets might occur during fall dispersal if they traveled far before relocating in other prairie dog towns.

Parasites and disease of black-footed ferrets were described by Boddicker (1968), Carpenter et al. (1976), Carpenter and Novilla (1977), and Carpenter and Hillman (unpublished manuscript). Ferrets are extremely susceptible to distemper, and this virus may pose a threat to ferret populations in areas where outbreaks occur among other wild and domestic animals. Inbreeding also has been discussed as a possible limiting factor in remnant populations. A captive male was a monorchid and suffered from diabetes mellitus; both conditions may be heritable. Sylvatic plague has been suggested as a possible threat to ferrets when prairie dog towns are infected, but no case has been reported.

BEHAVIOR. Black-footed ferrets are secretive and rarely observed. Ferrets can only be seen with regularity when females with young are located. The animals are primarily nocturnal except for occasional early morning activity of young. Females den in prairie dog burrows and bring young above ground in early July. The young remain in the prairie dog town until they disperse in September or early October. Hillman (1968) and Henderson et al. (1969) described the daily activity and behavior of females with young. Ferrets are less active in winter, and are probably solitary except during the breeding season in early spring.

Hillman and Carpenter (unpublished manuscript) observed the breeding behavior of captive ferrets. The male sniffed the genital region of an estrus female but made no attempt to mount until the animals had been together for several hours. This lack of aggressive behavior by the male was unlike that observed with Eurasian ferrets (*M. eversmanni* and *M. putorius*). During copulatory attempts, the male grasped the female by the nape of the neck and mounted in a prone position. Copulatory ties were prolonged, generally lasting one and one-half to three hours, and were accompanied by whimpering on the part of the female.

Vocalizations of a captive ferret were described by Progulske (1969). In the wild, ferrets chatter and hiss when frightened or alarmed. Females utter whimpering sounds when encouraging their young to follow. Little is known of olfactory communication. Odor recognition, however, aids ferrets in retracing the same course during nightly travels (Hillman, 1968).

Interspecific encounters between ferrets and prairie dogs were recorded by Hillman (1968) and Henderson et al. (1969). Apparently prairie dogs are formidable prey, and ferrets appear reluctant to pursue them above ground. Prairie dogs displayed aggressive behavior towards ferrets, including chase and harassment, direct contact then retreat, and covering of burrows occupied by ferrets.

REMARKS. Because the subterranean habits of ferrets prevent continuous observation, information is lacking on many aspects of the life history and ecology of the black-footed ferret. Renewed interest and funding for studies of rare and endangered species should encourage researchers to learn more of the ferret's status, distribution, and ecological needs.

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- Principal editors of this account were S. ANDERSON and D. F. WILLIAMS.
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CHARACTERISTICS OF THE BLACK-FOOTED FERRET

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The black-footed ferret (*Mustela nigripes*) has been known to science for a little more than a century. It was described in 1851 by Audubon and Bachman, who studied a skin from Fort Laramie, Goshen County, Wyoming. According to most authors, the species was not reported again until 1876, and for those 25 years many zoologists doubted its existence.

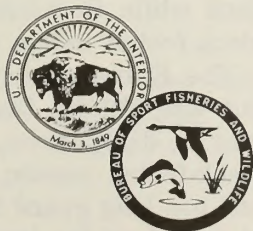
Ferret numbers and distribution

Apparently the black-footed ferret has never been abundant, because it has been reported only a few times during the last 100 years. Its use by Indians as a talisman in religious ceremonies suggests rarity. Stuffed ferrets, some decorated with colored cloth bands and feathers, have been found as Indian relics in Montana and Wyoming. The Plains Indians, like people everywhere, valued rare objects, and skins of the black-footed ferret, along with ermine skins and other relatively scarce furs, were used for decoration and ceremony. Since ferrets have been found less frequently than ermines as Indian artifacts, they probably were less common. Many authorities believe that black-footed ferrets may now be on the verge of extinction.

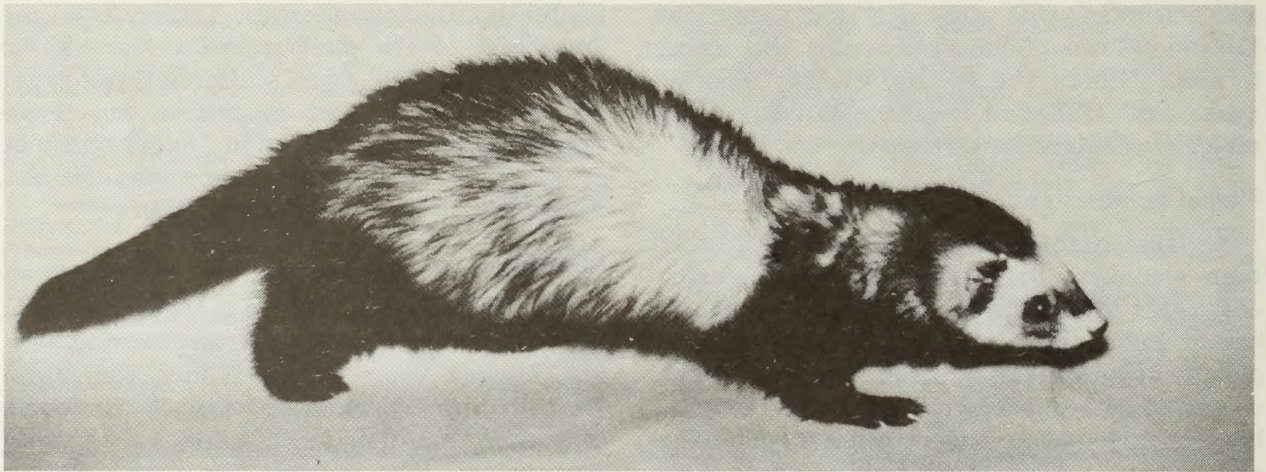
The original range of the black-footed ferret corresponded closely to that of the prairie dog, extending over the Great Plains area from Southern Canada to the west Texas plains, and from east of the one-hundredth meridian to Utah and Arizona. Small scattered ferret populations may still exist in prairie dog towns throughout this area. Individual animals may be so scattered that breeding opportunities are insufficient to maintain their numbers.

Identification

The nearest living relative of the black-footed ferret is an Old World ferret, the Siberian polecat (*Mustela eversmanni*). It has been postulated that the black-footed ferret's forebears came over from Asia to Alaska by a prehistoric land bridge that existed where the Bering Strait now lies. A domesticated form of another Old World ferret, the European polecat (*M. putorius*), is a common laboratory animal and a popular pet in the United States. In the past, it has also been used for rat control and for hunting. The European polecat and the black-footed ferret, though distinctly different species, are superficially alike in size and certain other



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Comparison of black-footed ferret (above) and European polecat. Note that although both animals have dark masks and dark legs, and tail length about one-fourth that of the body, the blackfoot has less conspicuous guard hairs, its tail is uniformly cylindric throughout its length, only the terminal third is black, and the muzzle is blunter. The European polecat's tail is tapered slightly throughout its length, two-thirds or more of it is black, and the muzzle is more pointed. Because the European polecat's fur color is extremely variable, ranging from white albino to extremely dark specimens, the color pattern of the tail seems to be the most reliable identification characteristic.

characteristics, and one can be mistaken for the other. This confusion is compounded by the practice of many pet dealers of selling polecats as "black-footed ferrets."

The black-footed ferret is about the size of a mink but is more slender and weasel-like; it has a total length of 18 to 24 inches, a tail length of 4 to 6 inches, and a weight of 1½ to 3 pounds. As in most species of the weasel family, the male is usually much larger than the female. The backs and sides of both sexes are buffy yel-

low with a darker saddle-shaped patch. The underparts are whitish. The feet, the legs, and the tip of the tail are black, and the coat does not turn white in winter. The ferret is the only black-footed native weasel in North America.

The European ferret is about the same size but less slender than the native species, and may be dark brown, albino, or marked like its black-footed cousin; the fur is much coarser and has long guard hairs. The dark tip extends at least half the length of the tail, whereas in

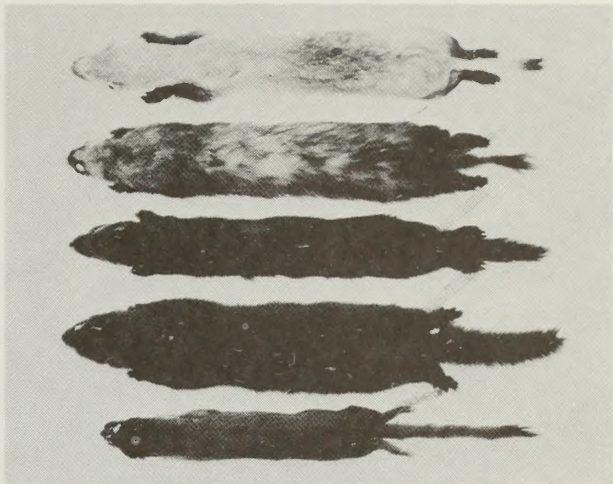
the native ferret it covers only about a third of the length of the tail. Apparently the European ferret survives very poorly in the wild in North America, self-sustaining feral populations rarely being found here.

The black-footed ferret has a more massive skull than a weasel or even a mink; it is broad between the eyes with a blunt muzzle and larger ears than most weasels. It has a typical weasel-shaped body, long and sinewy, and it moves in a weasel-like manner. The physical characteristics of the black-footed and European ferrets and long-tailed weasel are compared in the table.

Life history and habits

When ferrets breed is still a mystery, but probably the young are born in May or early June. Litters of 4 or 5 are the rule. Young of the year are not usually seen above ground until July, when they are one-half to two-thirds grown. Whether the adult male remains with the family is not known. The family group seems to disband in late August or September, when the young, presumably, move to other areas.

Black-footed ferrets live principally in prairie dog towns and feed to a great extent on these animals. Ferrets are primarily nocturnal, but are also active during daylight hours, especially in the summertime. They may be seen in prairie



Comparison of museum skin specimens of the black-footed ferret and other weasel-like animals that might be confused with it: black-footed ferret (top); European polecat, light phase; same, dark phase; mink; long-tailed weasel.

dog burrows with only their heads showing, or lying on the edge of the mounds. Sometimes they can be seen going from mound to mound, peering and sniffing down the burrows.

Ferrets and prairie dogs are often observed near each other and, while watchful, the prairie dogs seem little concerned about the presence of ferrets. Indeed, at times the prairie dogs are

COMPARISON OF THE PHYSICAL CHARACTERISTICS OF THE BLACK-FOOTED FERRET, THE DOMESTIC FERRET, AND THE LONG-TAILED WEASEL

	Weight	Length	Color	General appearance
Black-footed ferret	1½-3 pounds; male 1¾ to 2¼ pounds; female 1¼ to 2 pounds.	18-24 inches; tail ¼ of body length.	Buffy yellow back and sides, darker saddle; lighter underneath; black feet and legs; distal third of tail black; light face with contrasting black mask.	Sleek with short guard hairs; black mask usually very distinct; tail almost same diameter for full length; ears large for a weasel.
European ferret	1½-3 pounds	18-24 inches; tail ¼ of body length.	Straw to dark brown or colored like a black-footed ferret; distal two-thirds or more of tail black; mask paler and legs distinct. Albinos commonly produced in captivity.	Coarse fur with long, dark-tipped guard hairs; mask, if present, usually less distinct than above; tail usually tapered from base to tip, similar to otter tail in shape.
Long-tailed weasel	7-12 ounces	12-20 inches; tail nearly half or more of body length.	Light brown to dark chocolate brown with yellowish belly; turns white with black-tipped tail in northern part of range during winter; may possess a semblance of a brown mask when changing from white to brown color; in SW has contrasting black and white face markings.	Small, sleek, and sinewy; tail long; ears small.



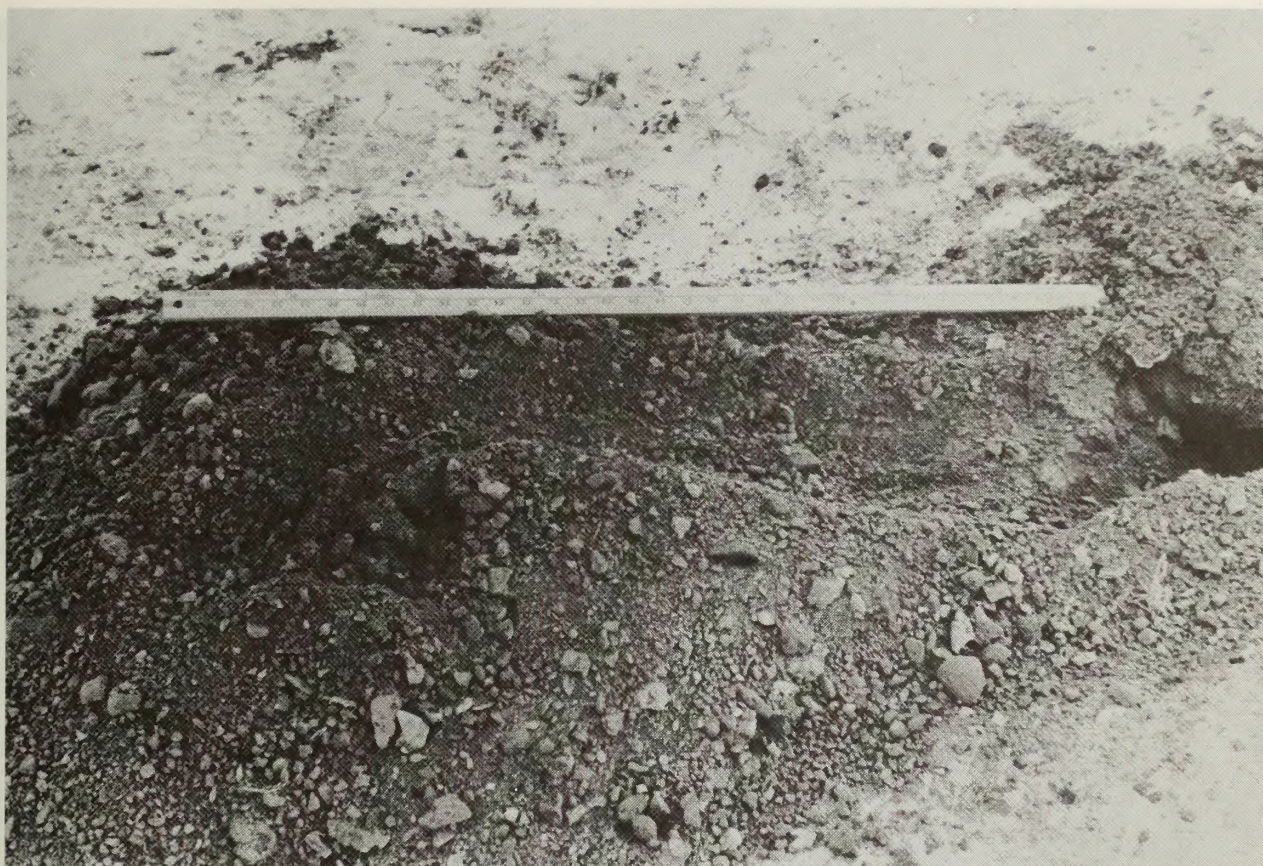
Two ferrets at a prairie dog burrow. Note the blunt muzzle and the large eyes and ears.

aggressive toward ferrets; they give chase as the ferrets run across the town, and even run alongside them and jump in front of them. This causes the ferrets to change direction. It is believed that this avoidance by the ferret does not denote fear, but only a disregard for the "dog," which seems bent on harassment rather than on actual combat.

I know of no one who has ever actually seen a ferret kill a prairie dog in the wild. However, when Conrad Hillman was a graduate student

at South Dakota State University, he saw a ferret capture an adult prairie dog on the surface of the ground and drag it kicking down a burrow. The ferret reappeared about 20 minutes later with blood on its muzzle.

I have seen ferrets dragging dead adult prairie dogs across a town, and others have observed ferrets in captivity killing the "dogs." I have also watched a ferret go down a burrow, emerge with a young prairie dog in its mouth, and take it down another burrow.



A fresh ferret trench.

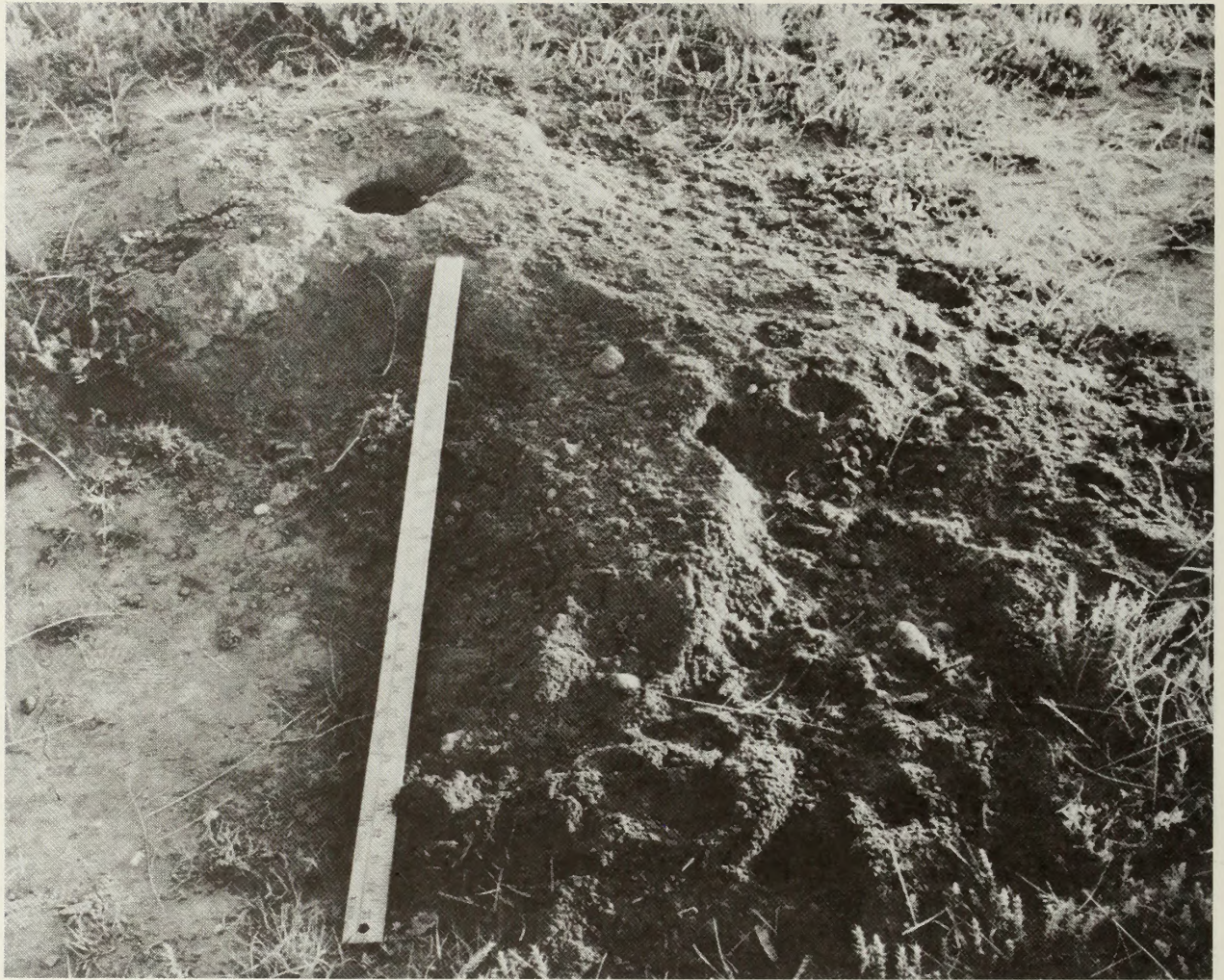
How to find ferrets

The best time of the year to see ferrets is in July and August. At this time, the adult female brings the young out of the burrow in the morning and at night. They can often be observed from an hour or two before dawn until mid-morning or noon. They may reappear after dark and remain active until midnight.

Usually the most effective way to look for ferrets is with a spotlight at night. A simple hand-held spotlight that plugs into an automobile cigaret lighter is sufficient. The best procedure is to park on a prairie dog town where one can see as much of the town as possible and sweep the light over the town every 10 minutes or so. In direct light the ferret's eyeshine is a very bright green, and the eyes appear large. Often when the light passes over the animal it will not face the beam, but when the beam is flashed back a second time it will. Therefore, it is a good idea to work the light back and

forth. A pair of binoculars is helpful in identifying the animal, for a weasel's eyeshine is also green. Under certain conditions, the eyes of badgers appear greenish, as do those of coyotes and even of cattle. In a prairie dog town on a dark night, a steer's eyes at 500 yards might be mistaken for those of a ferret at closer range.

Ferrets do much digging in prairie dog burrows, mostly at night. The ferret backs out of the burrow holding the soil against its chest with the front feet, then passes it to the back feet and kicks it out behind. It does this repeatedly, trip after trip, backing out progressively farther from the burrow in the same track. This procedure often leaves trench-like tailings of loose dirt on top of the ground. The trenches are usually about 6 inches wide, 2 to 3 inches deep, and 1 to 10 feet long. Sometimes, when ferrets dig, they do not form trenches but string soil outward, away from the mound.

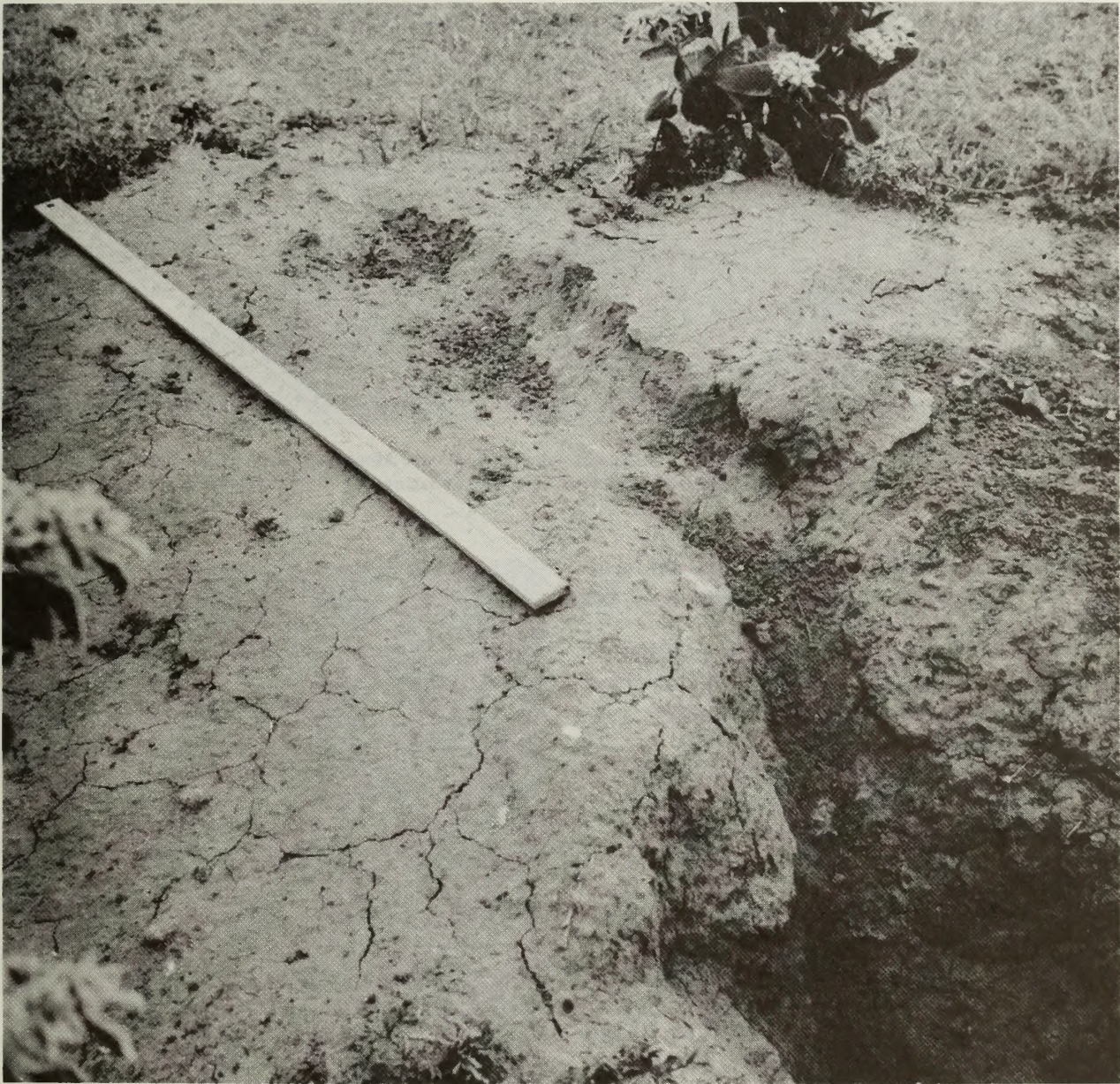


Fresh ferret activity. Soil is pulled outward and away from the mound for about 3 feet. Tracks in the foreground were made by a coyote.

In contrast, a digging prairie dog either carries the earth out and uses it to build up the mound or pulls the earth from outside the burrow in toward the mound. Sometimes, a prairie dog forms a trench when bringing dirt out of the burrow to rebuild the mound, but the trench usually curves around the burrow opening and does not normally extend beyond the mound itself. Soil strewn outward from the mound, whether or not a trench has been formed, is strongly indicative of ferret work. Since prairie dog digging and ferret digging can easily be confused, examinations for ferret sign should be made early in the morning. The prairie dog

is strictly a diurnal animal, and almost never comes out at night. Therefore, an early morning check for fresh sign eliminates prairie dogs as being responsible for any digging made during the night.

During warm weather when the prairie dogs are most active, they usually destroy ferret sign as soon as they come out in the morning; but in the winter when they are less active or the ground is frozen, the trenches may persist for a long time. Therefore, the best time of year to look for sign is in the winter, preferably when snow is on the ground and tracks can be seen extending from burrow to burrow. Ferret



An old ferret trench which probably has persisted for several months.

tracks, both in the snow and otherwise, and ferret scats are very similar to mink tracks and scats. However, ferret scats are seldom found, since most of them are deposited underground in burrows.

Prairie dogs have a penchant for covering up burrows occupied by ferrets or recently used by them. Though they may do this also when rattlesnakes, badgers, and coyotes use their bur-

rows, several freshly covered holes in a small town, or in a particular area of a town, should lead one to suspect the presence of a ferret. In covering these burrows, the prairie dog kicks dirt into the burrow-opening and then tamps it down tightly with its nose. Apparently, the ferret leaves this earthen prison with ease. In fact, a covered burrow where something has dug out from the inside and left an opening



Black-footed ferret scats. They are about $\frac{1}{4}$ inch in diameter and consist almost entirely of hair and bits of bone. Notice the segmentation and twisting.

about the size of a silver dollar may be evidence that the "masked mustelid" has made good his escape.

Anyone having knowledge of the presence of ferrets, or having seen any of the ferret signs described above, should promptly notify:

Biologist

Bureau of Sport Fisheries and Wildlife

919 Main Street, Room 210E

Rapid City, South Dakota 57701

or—

Director

Patuxent Wildlife Research Center

Laurel, Maryland 20810

The date and precise location of the observation, and other pertinent information, should be given. These records may provide clues to the status and distribution of this little-known animal. A more complete knowledge of the black-footed ferret can then be applied in management to prevent its extinction.

Photo credits:

European polecat by Rex G. Schmidt;

museum skins by Ray C. Erickson;

two black-footed ferrets by Duane Rubink;

all others by Donald K. Fartenbery.



Ferret tracks in crusty snow. The tracks are about 14 to 18 inches apart and resemble those made by mink.

APPENDIX II

Checklist of items needed to conduct nocturnal and diurnal ferret surveys

Nocturnal Surveys

- ☐ Binoculars
- ☐ Spotting scope
- ☐ Hand-held spotlight for each person (or 1 roof-mounted spotlight for 1 person)
- ☐ Extra spotlight bulbs (100w aircraft landing light)
- ☐ Maps of route, area, etc.
- ☐ Warm clothes (gloves, especially if using hand-held spotlight)
- ☐ Notepad
- ☐ Snacks, thermos, etc.
- ☐ Camera with flash

Diurnal Surveys

- ☐ Binoculars
- ☐ Measuring tape (for tracks or diggings)
- ☐ Notepad
- ☐ Camera (to photograph sign)
- ☐ Maps of area
- ☐ Snacks, thermos, etc.

APPENDIX III

Additional References to Black-footed Ferret Literature (Prepared by S. J. Martin)

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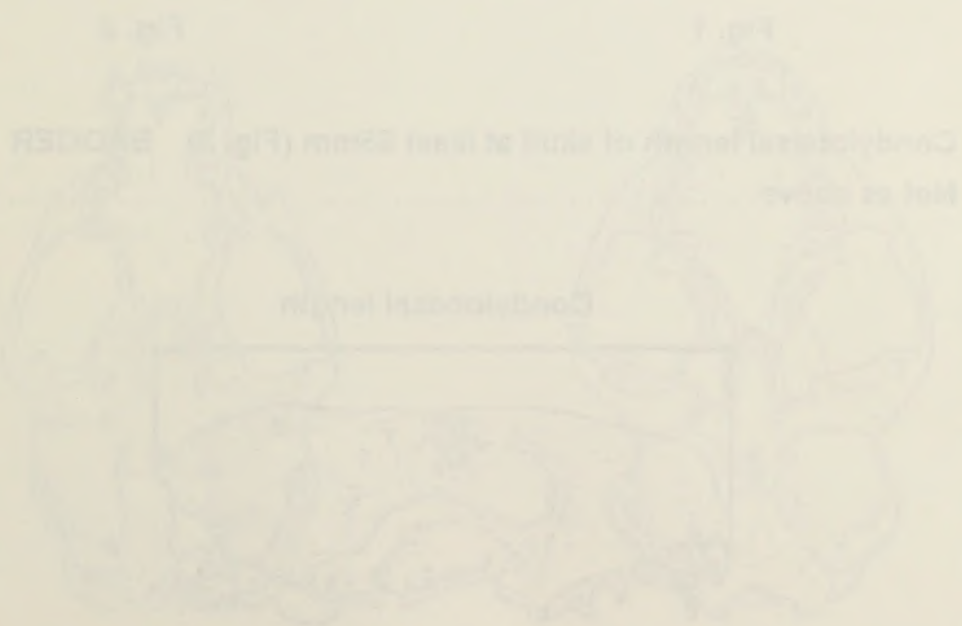
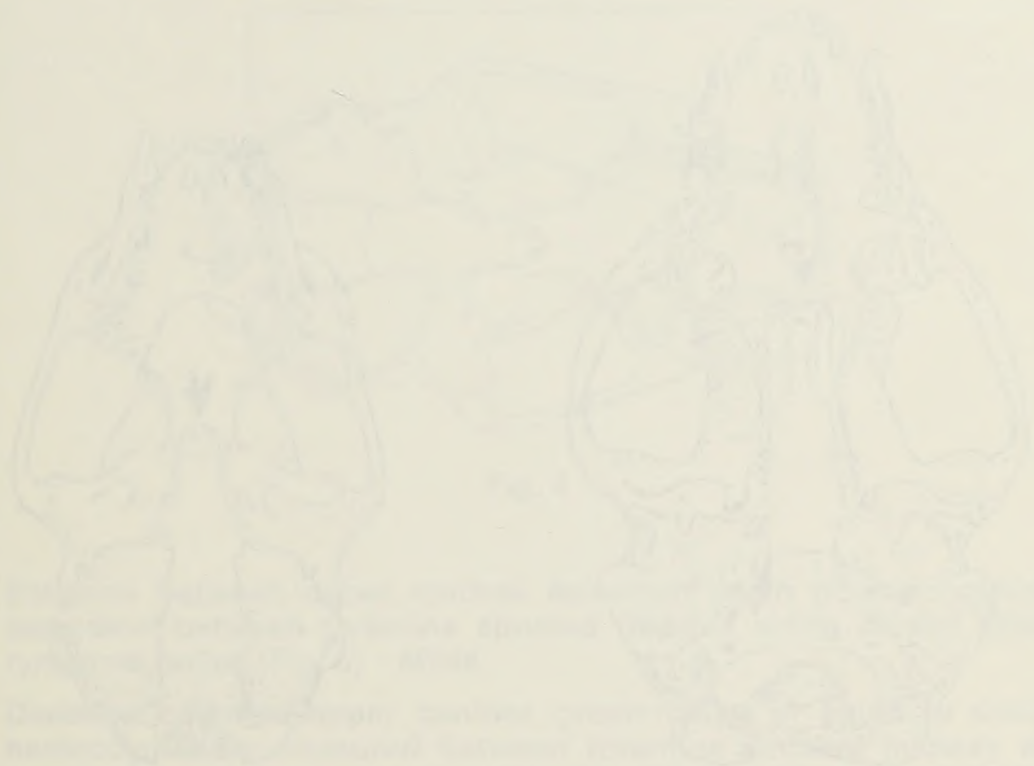
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APPENDIX IV

A key to ferret, mink, weasel, and badger skulls (taken from: Hoffman, r.s. and D.L. Pattie. 1968. A guide to Montana mammals: identification, habitat, distribution, and abundance. Univ. Montana Publ., Missoula).



1. Eight pairs of teeth in upper jaw and nine in lower jaw. WEASELS, MINK, BLACK-FOOTED FERRET, BADGER, SKUNK 2
2. Palate extends only to end of last molar of upper jaw (Fig. 1). SKUNKS
Palate extends beyond last molar of upper jaw (Fig. 2) 3

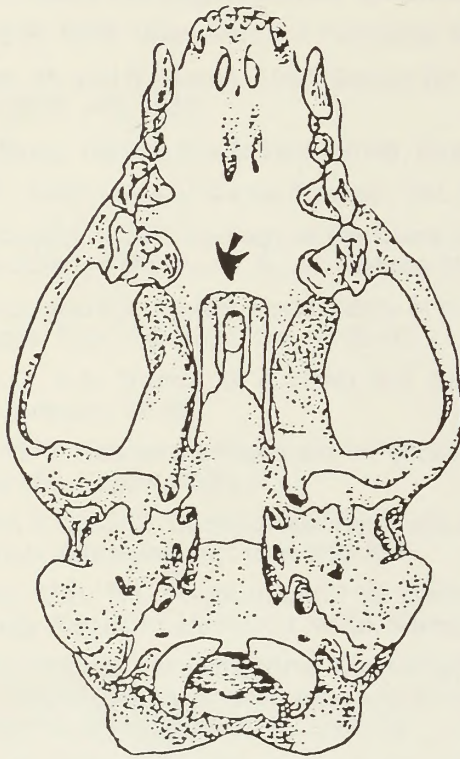


Fig. 1

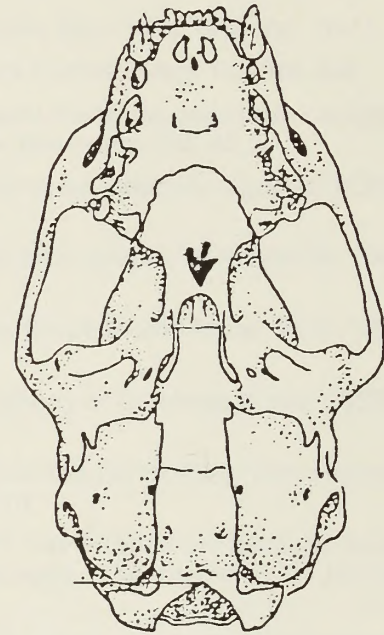


Fig. 2

3. Condylobasal length of skull at least 85mm (Fig. 3) BADGER
Not as above 4

Condylobasal length

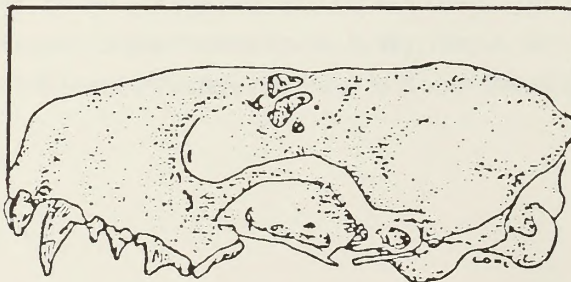


Fig. 3

4. Skull large. Basilar length of hensel (measured from posterior border of incisors to anterior point of foramen magnum, Fig. 4) more than 50mm 5
- Skull small. Hensel length less than 50mm. **WEASELS**

Hensel length

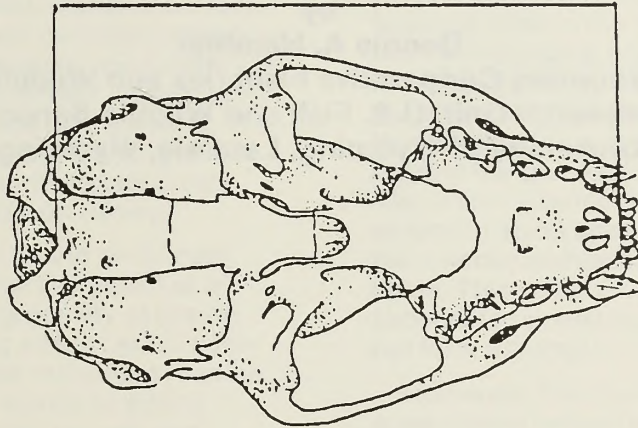


Fig. 4

5. Distance between upper canines less than width of basioccipital as measured between foramina situated midway along medial sides of tympanic bullae (Fig. 5) **MINK**

Distance between upper canines greater than or equal to width of basioccipital as measured between foramina situated midway along medial sides of tympanic bullae (Fig. 6). **BLACK-FOOTED FERRET**

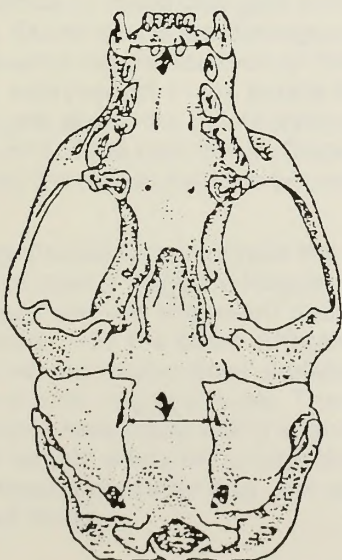


Fig. 5

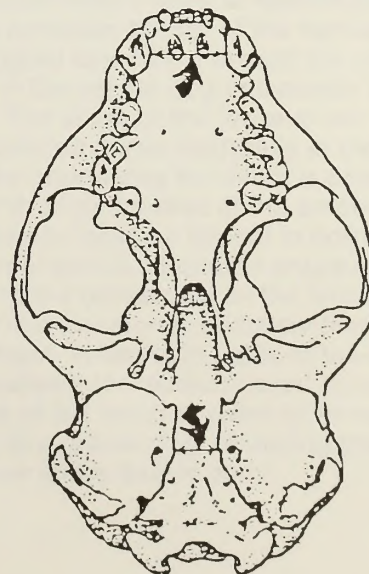


Fig 6

APPENDIX V

A Post-Cranial Comparison of the Prairie Dog [*Cynomys spp.*] and the Black-footed Ferret [*Mustela nigripes*]

by

Dennie A. Hammer

**Wyoming Cooperative Fisheries and Wildlife
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University of Wyoming, Laramie, Wyoming**

Skeletal Remains of Ferrets

Black-footed ferret skulls and skeletal remains are evidence of past ferret presence. Such evidence has recently been used to extend the former range of the ferret in south-western Wyoming (Martin, 1983). Ferret remains are, however, rare finds. Clark et al. (1983a, in ms.) found only 10 skulls after intensive on-foot coverage of the 2868 ha ferret occupied region. Martin and Schroeder (1979, 1980) and Smith (1982) found a total of 7 skulls after having surveyed over 12,000 ha of prairie dog towns in southwestern and southcentral Wyoming. Finding this kind of evidence should dictate a very intensive and extensive follow up survey.

Skeletal remains are often found on or near burrow mounds and are generally found as a result of the burrow cleaning activity of prairie dogs. Subsequent to finding a ferret skull, additional skeletal remains (lower mandibles, canine teeth, vertebrae) have been found by sifting through the mounded soil with shovels and screens (Martin and Schroeder, 1979).

Skulls: Ferret skulls are quite similar in appearance to both mink and skunk skulls. In the mink the distance between the upper canines is usually less than the width between the midpoints of the tympanic (auditory) bullae. In the ferret the inner distance between upper canines is greater than or equal to the width between the midpoints of the tympanic bullae (Glass, 1975). The tympanic bullae of the mink are squarred anteriorly as opposed to the more circular appearance of the bullae in the ferret skull. In addition, the rostrum of a mink skull is narrower and noticeably more elongate than that of the ferret. Skunk skulls are distinguished from ferrets by examining the location of the last upper molar with respect to the palate of the upper jaw. In the skunk the palate extends back only to the end of the last molar (Glass, 1975). In the ferret the palate extends beyond the last molar.

While conducting diurnal ferret surveys the skeletal remains of prairie dogs are frequently encountered. Therefore, it is important that field personnel be familiar with the basic differences in the **major** cranial and post-cranial skeletal structures of the prairie dog and ferret. The following comparisons were made using specimens of an adult female white-tail prairie dog, an adult female black-tail prairie dog, and adult male black-footed ferret.

Atlas: The most noticeable difference in the atlas of the prairie dog and ferret is size. The atlas of the ferret is nearly twice as large as that of a prairie dog and has broad wings which extend laterally from both sides of the neural canal (fig. 1,1).

Scapula: The scapula of the prairie dog and ferret are similar in size (fig. 1,2). Significant differences arise in the overall shape of this structure. In the prairie dog, the degree of inclination in the acromion spine (proximal to distal end) is much greater than that of the ferret. In addition, the prairie dogs acromion process extends beyond the glenoid fossa and is "boot" shaped. Also, when viewing the scapula laterally, the acromion spine appears to form a triangle with the anterior and vertebral borders of the scapula blade. This same spine in the ferret scapula appears to parallel the anterior border and **does not** form a triangle.

Humerus: The humerus of the prairie dog has a prominent deltoid crest (fig. 1,3). This same crest is rather broad and flat in the ferret. Both the prairie dog and ferret humerus have an entepicondylar foramen located distally and medial to the body. The shaft of a prairie dog humerus is nearly straight and curves slightly concave just below the head where as in the ferret, the curvature of the shaft begins will before the head.

Innominate: The innominate (pelvis or hip bone) is composed of three distinct parts (ilium, ischium, and pubis) which unite to form a single bone (Gilbert, 1980). The shape of this bone (articulated or disarticulated) is the most obvious feature used in identification (fig. 2,1). The posterior border of the ischium in the ferret is angled downward toward the pubic symphysis. In the prairie dog this border is flat or nearly flat. The ilium of the ferret is very straight and broadened dorso-ventrally at the anterior end. In the prairie dog the ilium is concave laterally and strongly hooked at the anterior end. The obturator foramen (found in both halves of the innominate) is circular in shape and small relative to the bones size, in the ferret. In the prairie dog this foramen is relatively large and elliptical in shape. When both sides of the innominate are articulated (or reconstructed as such) the hip bone of the ferret appears to be narrower than that of a prairie dog, reflecting the long thin nature of the ferrets body.

Femur: When examining the femur of a ferret and prairie dog two distinct features are evident. There exists on the prairie dog femur a third trochanter and a prominent lesser trochanter (fig. 2,2). Together they form a broad, relatively flat area at the proximal end (posterior side) of the shaft. The ferret femur **does not** have a third trochanter, and the lesser trochanter is small and bump like in appearance.

Tibia: The tibia of prairie dog differs slightly from that of a ferret in that at the distal end (medial side) there is a small crest just below the epiphysis (fig. 3,1). There is **no** crest on a ferret tibia.

Ulna: The radius and ulna of the prairie dog and ferret are nearly identical. The only obvious difference occurs in the ferret. There is a prominent ridge (crest or bump) located medially at the approximate midpoint of the shaft of both bones (fig.3,2). This ridge is not found on either the radius or ulna of the prairie dog.

Fibula: The shape of the fibula head is broad and nearly symmetrical with the midline of the shaft in the ferret (fig. 3,3). In the prairie dog the head mass is skewed toward the medial side of the shaft and **is not** symmetrical with the shafts midline.

FIGURE 1,1. ATLAS



FIGURE 1,2. SCAPULA

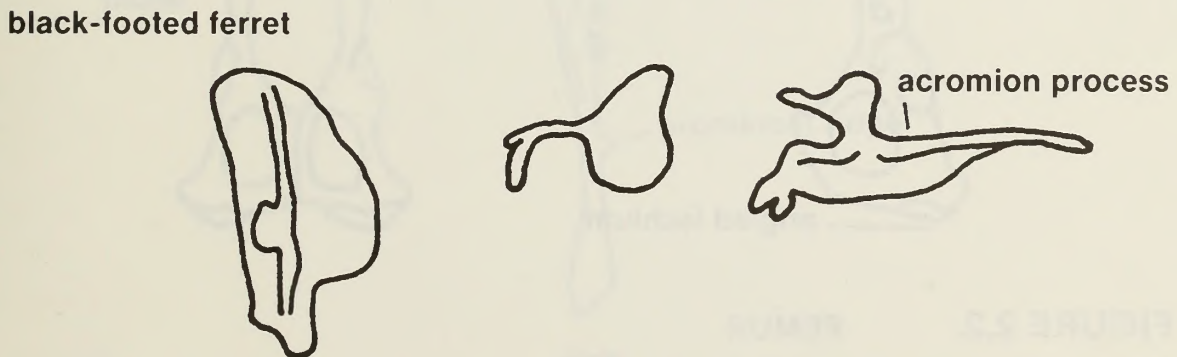
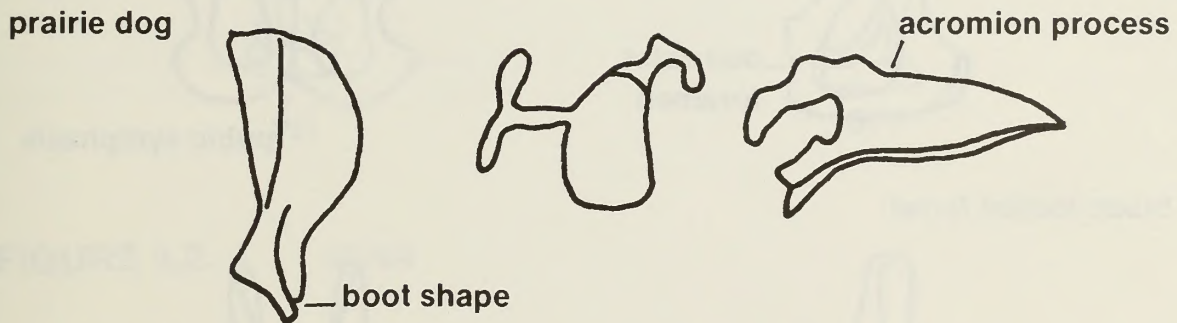


FIGURE 1,3. HUMERUS

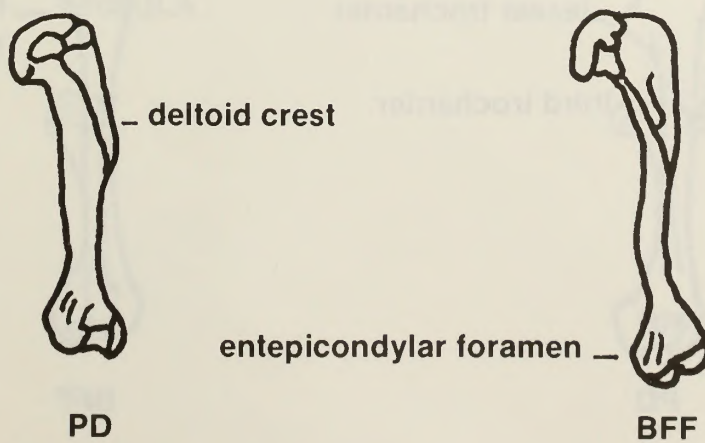
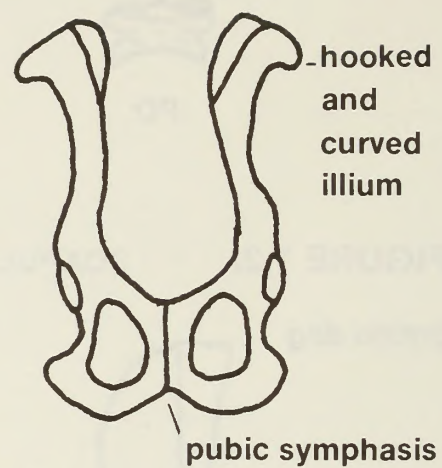
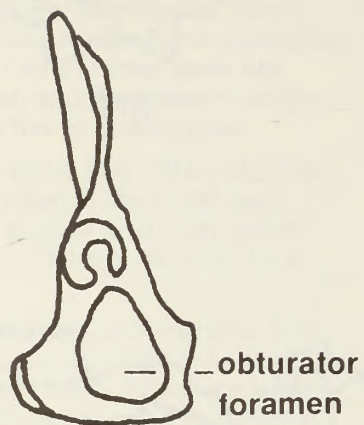


FIGURE 2,1. INNOMINATE

prairie dog



black-footed ferret

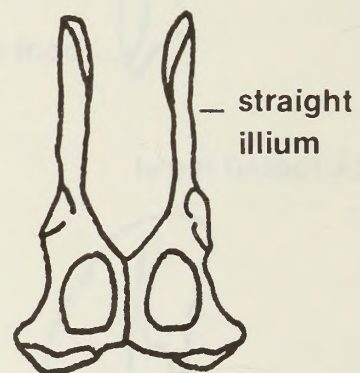
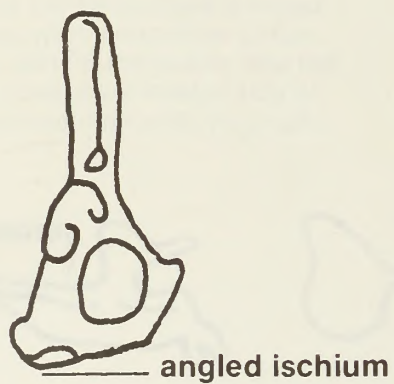


FIGURE 2,2. FEMUR

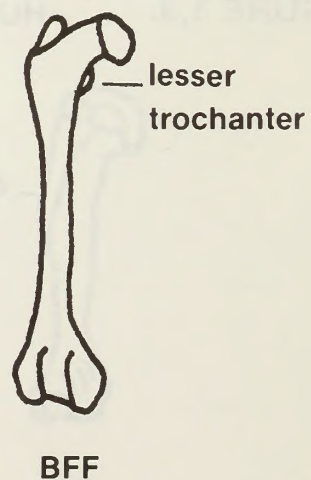
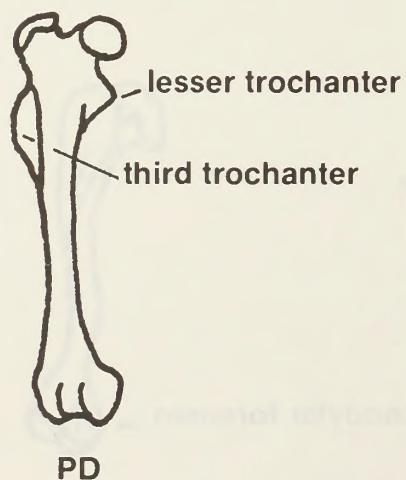


FIGURE 3,1. TIBIA

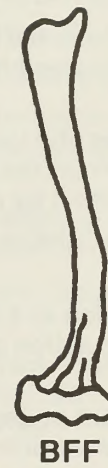
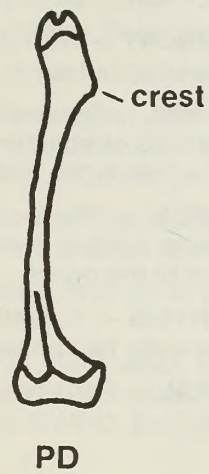


FIGURE 3,2. ULNA

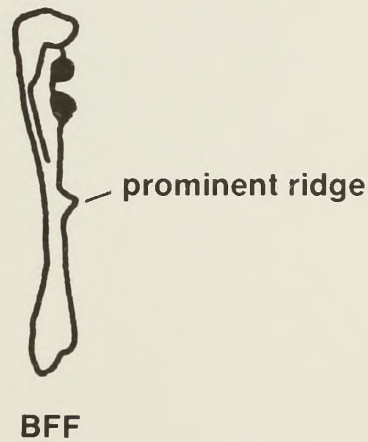
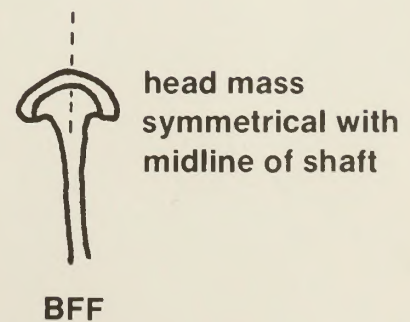
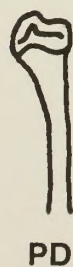


FIGURE 3,3. FIBULA



GLOSSARY OF TERMS

ANTERIOR — Of, pertaining to, or toward the front end.

ARTICULATED — To be jointed or connected.

DISTAL — Situated away from the base or point of attachment or from any named reference point.

EPIPHYSIS — The end part of a long bone which is at first separated from the main part by cartilage, but later fuses with it by ossification.

FORAMEN — Any opening, orifice, or perforation, through bone.

FOSSA — A pit or depression in a bone. Frequently a site of bone articulation or muscle attachment.

INCLINATION — The extent or degree of incline from a horizontal or verticle position.

LATERAL — Located away from the midline; at or near the side(s).

MEDIAL — Lying in or near the plane dividing a mammal into two mirror-image halves.

POSTERIOR — Of or pertaining to the rear end.

PROMINENT — Noticeable at once, protruding or projecting outward.

PROXIMAL — Situated toward or near a point of reference or attachment, e.g., the proximal end of a limb is the end closest to the body.

ROSTRUM — The facial region of the skull, anterior to a plane drawn through the anterior margins of the orbits.

SYMPHYSIS — A relatively immovable articulation between two bones.

VENTRAL — Pertaining to the under or lower surface.

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